TAB	DESCRIPTION	ACTION
1	SUPERINTENDENT'S K-12 UPDATE	Information Item
2	EDUCATION FREEDOM TAX CREDIT SCHOLARSHIP GRANTING ORGANIZATIONS	Information Item
3	STRATEGIC PERFORMANCE PLAN MATRIX	Action Item
4	ASSESSMENT ITEM REVIEW COMMITTEE RECOMMENDATION	Action Item
5	SCIENCE CONTENT STANDARDS REVIEW	Action Item

SUBJECT

Superintendent's K-12 Update

BACKGROUND

Idaho State Board of Education bylaws establish the Superintendent of Public Instruction as responsible for carrying out policies, procedures, and duties prescribed by the Constitution of the State of Idaho and by Idaho Code or as established by the Board for all elementary and secondary school matters.

Debbie Critchfield was sworn into office as the Idaho Superintendent of Public Instruction on January 2, 2023.

PROPOSAL

Superintendent Critchfield will update the State Board of Education on the following priorities moving forward:

- K-12 Funding Formula Work
- Statewide Professional Development Day (October 9)
- Readiness Summit (October 29)

IMPACT

Any proposals related to the Superintendent's priorities will be brought to the Board following appropriate Board and legislative processes as necessary.

IDE STAFF COMMENTS AND RECOMMENDATIONS

Informational item; no Department staff recommendations.

BOARD ACTION

This item is for informational purposes only.

APPLICABLE STATUTE, RULE OR POLICY

Idaho Code § 33-125, § 33-125A, § 33-127
Board Policy I. Bylaws, Section E.4

SUBJECT

Education Freedom Tax Credit Scholarship Granting Organizations

BACKGROUND

The Education Freedom Tax Credit (EFTC) scholarship program was authorized as part of the 2025 One Big Beautiful Bill Act passed by Congress. The program allows individuals or corporations to donate money directly to approved non-profit Scholarship Granting Organizations (SGOs) in Idaho. Donors can then claim a dollar-for-dollar federal tax credit.

During the 2026 Legislative Session, the Governor issued Executive Order 2026-03, which opts Idaho into the EFTC program and requires the Idaho State Department of Education (Department) to develop an application process for SGOs who wish to operate in Idaho. It also requires the Department to prepare a list of the approved SGOs for submission to the US Department of the Treasury and post those items to its website.

PROPOSAL

Idaho non-profit entities are eligible to be SGOs. Nationwide non-profit entities are also eligible to be SGOs if they are operating in Idaho. All eligible SGOs are expected to meet the requirements established by the U.S. Treasury. SGOs are required to dedicate 90% of their operating budgets towards scholarships, verify family eligibility based on income, and complete programmatic audits and federal reporting.

The U.S. Treasury is releasing additional requirements that will be incorporated into the application process.

The Department will review SGO applications to determine if each organization meets the program requirements and has the capacity to implement the program. Currently, statewide and national scholarship organizations, district education foundations, statewide professional organizations, and other non-profits have expressed interest in being included on Idaho's list. Each SGO will determine the types of qualifying programs, educational services, and expenses they will cover and how.

The Department will submit a list of the qualified Scholarship Granting Organizations (SGOs) to the US Department of the Treasury by January 1, 2027. The list will be published on the Department's website. Additional updates and information will be provided to the Board as requested.

IMPACT

The Department will continue to follow the processes and timelines established by the federal government to ensure Idaho taxpayers will have access to the EFTC program. Once the list of SGOs is created and posted on the Department's website, taxpayers can choose which SGO to apply to based on the support each one offers. Taxpayers will receive a non-refundable credit for 100 percent of a

qualifying donation to their chosen SGO, up to an annual limit of $1,700. The US Treasury will determine if the amount for married taxpayers filing jointly will be $3,400.

IDE STAFF COMMENTS AND RECOMMENDATIONS

The Department is in regular communication with the federal government regarding the EFTC program, and the process being used to identify SGOs is thorough and in alignment with applicable federal laws and Executive Order 2026-03, as issued by Governor Little.

BOARD ACTION

This item is for informational purposes only.

APPLICABLE STATUTE, RULE OR POLICY

Idaho Code § 33-144
Executive Order No. 2026-03

SUBJECT

Strategic Performance Plan Matrix

BACKGROUND

To support the implementation of Senate Bill 1339 (2026), the Idaho State Department of Education (Department) convened a committee consisting of 12 education stakeholders representing each of Idaho's six educational regions.

Committee membership included school board members, legislators, superintendents, curriculum and instructional leaders, and representatives from organizations such as the Idaho Association of School Administrators (IASA).

The committee was charged with designing a practical framework for statewide implementation of Senate Bill 1339, including planning requirements, stakeholder engagement processes, performance measures, and accountability expectations to ensure meaningful and sustainable improvement efforts in local school districts.

The committee met six times between May and July 2026. Throughout the process, Superintendent Debbie Critchfield was regularly consulted and provided feedback on key components of the framework and its implementation approach.

PROPOSAL

The Strategic Performance Plan Matrix provided as Attachment 1 is designed to help districts develop effective, locally driven plans that focus on improving student outcomes while strengthening community engagement. The framework includes required performance measures and four-year targets in the areas of:

- Early Literacy
- English Language Arts
- Mathematics
- College and Career Readiness
- Graduation Rates

In addition, districts are asked to establish measurable goals, identify research-based strategies, develop specific action steps, and describe how progress will be monitored and reported. The framework also includes expectations for ongoing local board governance and oversight through regular review of strategic plan progress.

While the goals, metrics, and performance targets are important, the committee emphasized that the most critical aspect of the Strategic Performance Plan is the planning process itself.

The intent of Senate Bill 1339 is not simply to create a compliance document, but to foster meaningful collaboration among school boards, district leadership, educators, parents, students, business leaders, and community stakeholders. The quality of stakeholder engagement, the identification of local priorities, and the

development of actionable improvement strategies will ultimately determine the value and effectiveness of each district's plan.

The framework places significant emphasis on stakeholder engagement, needs assessment, action planning, implementation monitoring, and continuous improvement. As described in the guidance materials, a high-quality strategic plan should provide not only desired outcomes but also a clear roadmap for achieving those outcomes through research-based strategies and measurable actions.

The proposed accountability framework further reinforces this approach by evaluating strategic performance based on four factors:

1. Achievement of established targets.
2. Growth toward goals when targets are not fully met.
3. Implementation of the strategies and action steps identified in the plan.
4. Ongoing progress monitoring and adjustment based on results.

Future Implementation Timeline

The first round of district Strategic Performance Plans will be due to the Department by **October 1, 2027**.

To support successful implementation, the Department will provide a series of statewide training and technical assistance opportunities, including:

- **September 16, 2026, at 2:00 p.m. MST**: Statewide virtual webinar for superintendents and district office staff.
- **December 1-2, 2026 (Boise)**: Strategic Performance Plan training for superintendents, assistant superintendents, and school board members.
- **December 3-4, 2026 (Pocatello)**: Strategic Performance Plan training for superintendents, assistant superintendents, and school board members.
- **December 8-9, 2026 (Moscow)**: Strategic Performance Plan training for superintendents, assistant superintendents, and school board members.

These trainings will focus on stakeholder engagement, goal development, action planning, performance monitoring, and board governance practices to help districts build strategic plans that are both locally meaningful and aligned with state expectations.

IMPACT

The Board’s approval of the Strategic Performance Plan Matrix (Attachment 1) will allow the Department to launch their outreach and training plan and will allow school districts and public charter schools to begin developing their local strategic performance plans for submission by October 1, 2027.

IDE STAFF COMMENTS AND RECOMMENDATIONS

The proposed Strategic Performance Plan Matrix meets the requirements established by Senate Bill 1339 (2026) and provides Idaho school districts and charter schools with the guidance needed to develop meaningful strategic plans for submission in 2027. The Department developed the framework in consultation with Idaho education stakeholders and has an appropriate training plan.

ATTACHMENTS

Attachment 1 – Strategic Performance Plan Matrix

BOARD ACTION

I move to adopt the Strategic Performance Plan Matrix, as provided in Attachment 1, in alignment with Section 33-320, Idaho Code.

Moved by_____ Seconded by_____ Carried Yes_____ No_____

APPLICABLE STATUTE, RULE, OR POLICY

Idaho Code § 33-320

Vision/Mission and Stakeholder Engagement	
Please provide your vision and mission statements.	
Mission Statement	
Vision Statement	
The local governing board and the school district superintendent or charter administrator shall collaborate to develop the strategic performance plan by coordinating outreach to students, parents, educators, local industry partners, and the business community, as appropriate.	
Please provide a summary of stakeholder engagement process.	

Vision/Mission and Stakeholder Engagement	
Please provide your vision and mission statements.	
Mission Statement	
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Please provide a summary of stakeholder engagement process.	

Student Academic Proficiency								
Area	**Measurement Tool**	**All Students**	**Baseline**	**28-29 Target**	**29-30 Target**	**30-31 Target**	**31-32 Target**	**Result**
Early Literacy	Specify the assessment tool used (e.g., IRI, local assessment, or other assessment utilized)	Grades K-3						
Literacy	Specify the assessment tool used (e.g., ISAT, local assessment, or other assessment utilized)	Include at least 5 grade levels in grades 4-12						
Math	Specify the assessment tool used (e.g., ISAT, local assessment, or other assessment utilized)	Include at least 5 grade levels in grades 4-12						

Student Academic Growth								
Area	**Measurement Tool**	**Economically Disadvantaged**	**Baseline**	**28-29 Target**	**29-30 Target**	**30-31 Target**	**31-32 Target**	**Result**
Early Literacy	Specify the assessment tool used (e.g., IRI, local assessment, or other assessment utilized)	Grades K-3						
Literacy	Specify the assessment tool used (e.g., ISAT, local assessment, or other assessment utilized)	Include at least 5 grade levels in grades 4-12						
Math	Specify the assessment tool used (e.g., ISAT, local assessment, or other assessment utilized)	Include at least 5 grade levels in grades 4-12						

College and Career Readiness								
Area	**Metric**	**All Students**	**Baseline**	**28-29 Target**	**29-30 Target**	**30-31 Target**	**31-32 Target**	**Result**
Graduation Rate	Graduation Rate	Grade 12						
College Readiness and Career Readiness	Enter the metrics your LEA will use, either from the list provided or one developed by your LEA. Metrics related to the number of students completing the FAFSA, developing postsecondary plans, or submitting applications to postsecondary institutions will not be considered.	Some or all students in grades 9-12						

Districts may submit a link to a district-created document that contains the requested information. This is an acceptable method of response; however, the submission must also identify the specific page number(s) where the requested information can be found to facilitate the review process.where the requested information can be found to facilitate the review process.

Early Literacy

Literacy

Math

College Readiness and Career Readiness

Graduation Rate

Governance & Board Stewardship		
At least quarterly, review, discuss, and approve progress reports on two (2) or more key areas of the strategic performance plan at a regular or special board meeting.		
Date of Board Meeting	**Which indicator was discussed?**	**Summary of Conversation**

Possible Strategic Performance Plan Timeline (implementation)

Strategic Performance Plan Timeline

Phase 1: Orientation & Alignment

Facilitate discussions with district leadership, principals, and the school board
Clarify purpose, scope, and success criteria for the strategic plan
Establish project governance, roles, and communication structures
Develop initial action plan and timeline

Phase 2: Data Review & Stakeholder Engagement

Conduct comprehensive data analysis (early literacy, ELA, math, college & career readiness)
Review current initiatives, performance trends, and gaps
Gather input from stakeholders (staff, students, families, community, industry partners)
Summarize findings in a needs assessment report

Phase 3: Goal Setting & Strategy Development

Establish measurable, outcomes-based goals for key priority areas
Identify evidence-based strategies and priority actions
Define success metrics and progress indicators

Phase 4: Plan Development

Develop the full Strategic Performance Plan, including:
Goals and performance targets
Research-based strategies
Detailed action steps
Roles and responsibilities
Resource alignment (staffing, funding, supports)
Monitoring and reporting processes
Present draft plan to stakeholders for feedback
Refine plan based on input
Obtain formal school board approval
Submit plan to the State Department of Education
Prepare implementation supports and communication materials

Strategic Plan Accountability Framework

Strategic Performance Progress is determined by considering what was accomplished (target attainment), the progress made toward unmet targets (growth), and the extent to which the LEA implemented the strategies and action steps outlined in its strategic plan (implementation).

Strategic Performance Progress (SPP)

An LEA will be considered to have made Strategic Performance Progress when it demonstrates implementation of stated strategies, accomplishment in a majority of goal areas, which includes growth, and progress monitoring.

Each year, as part of the strategic plan submission process, LEAs will complete an annual self-assessment that documents progress toward achieving the goals and priorities identified in their strategic plan. The self-assessment is intended to provide evidence of implementation, progress, and results, and will include, at a minimum, the following components:

1. Target Attainment

Did the LEA meet the majority of performance goals and growth targets established in its strategic plan?

2. Growth

Did the LEA demonstrate measurable improvement toward its goals, even if established targets were not fully achieved?

3. Implementation

Did the LEA implement the research-based strategies and complete the action steps identified in its strategic plan?

4. Progress Monitoring and Adjustment

Did the LEA regularly monitor progress, analyze results, and make appropriate adjustments to strategies, action steps, or supports based on identified needs?

This annual self-assessment will serve as the primary evidence used to determine whether the LEA has demonstrated Strategic Performance Progress (SPP) through a combination of target attainment, growth, implementation, and ongoing progress.

SUBJECT

Assessment Item Review Committee Recommendation

BACKGROUND

In accordance with Section 33-134, Idaho Code, the Idaho State Board of Education appointed thirty (30) individuals to serve on the Assessment Item Review Committee.

The committee's membership is established in state law; the committee is required to include two parents, one public or charter school teacher, one school district or public charter school administrator, and one member from a school district board of trustees or charter school board of directors. The membership must include one individual from each of Idaho's six educational regions.

The committee reviews the computer-adaptive test questions that make up the following assessments:

- Idaho Standards Achievement Test (ISAT) ELA/Literacy;
- ISAT Mathematics;
- ISAT Science;
- Idaho Reading Indicator (IRI).

Based on their review of the test items, the committee is authorized to make recommendations to the Idaho State Board of Education and the Idaho Department of Education to revise or eliminate summative computer-adaptive test questions from the assessment forms.

PROPOSAL

During the 2026-2027 Assessment Item Review Committee meeting, the committee, by majority rule, flagged zero (0) IRI items, zero (0) ISAT ELA items, zero (0) ISAT Math items, and one (1) ISAT Science item for recommendation for removal or revision. Department staff reviewed the item and concurs with the committee's recommendation to remove the flagged ISAT Science item from the assessment item pool.

Assessment items are protected due to test security and their proprietary nature. The Board has been provided with secure access to review the ISAT Science item proposed for removal.

IMPACT

The assessment item review process cost $64,172.00 to facilitate (see Attachment 5).

Based on the Idaho State Board of Education's decision in previous years to exclude all items and passages recommended by the Assessment Item Review Committee, Idaho has a separate item configuration for the online delivery of the ISAT Science assessments at an annual fee of $57,000. Exclusion of the item

proposed by the 2026 Assessment Item Review Committee will not incur additional costs for the Idaho Department of Education.

Board approval of the proposal will result in removal of the flagged ISAT item from the pool of test items given to students.

IDE STAFF COMMENTS AND RECOMMENDATIONS

The assessment item review process facilitated by the Department is done by a committee appointed by the Board in alignment with statute.

The flagged ISAT Science item is written in a manner where a student's personal preference could result in selection of the incorrect answer even if the student understands the underlying content. Therefore, it is appropriate to remove the item to ensure that students' knowledge and skills are assessed and that personal preferences are not a factor in the ability to select the correct answer.

ATTACHMENTS

Attachment 1 – 2026 IRI Assessment Item Review Committee Report
Attachment 2 – 2026 IRI Assessment Item Review Committee Presentation
Attachment 3 – 2026 ISAT Assessment Item Review Committee Report
Attachment 4 – 2026 ISAT Assessment Item Review Committee Presentation
Attachment 5 – 2026 Assessment Item Review Expenditure Report
Attachment 6 – 2026 Assessment Item Review Committee Members and Attendance

BOARD ACTION

I move to accept the 2026 Assessment Item Review Committee's recommendation and to remove the one (1) flagged Idaho Standards Achievement Test Science item from the assessment's operational item pool.

Moved by _____ Seconded by _____ Carried Yes _____ No _____

APPLICABLE STATUTE, RULE OR POLICY

Idaho Code § 33-134
IDAPA 08.08.02.03

REFERENCE

February 2015	Board approved the removal of an audio clip and associated items.
December 2016	Board approved the removal of the three (3) ELA items, one (1) grade 11 passage with five (5) associated items, one (1) grade 8 passage with eleven (11) associated items, and one (1) grade 6 math item.
October 2017	Board approved the removal of one (1) grade 4 ELA item.
November 2018	Board approved the removal of one (1) grade 5 ELA item.

October 2019	Board approved the removal of one (1) high school ELA item and one (1) high school science item.
December 2022	Board approved the removal of one (1) grade 4 ELA item.
December 2023	Board approved the removal of one (1) ISAT ELA/L stimulus set was determined to not pass the Idaho Bias and Sensitivity guidelines. This stimulus set affected 14 total items that were also rejected
October 2024	Board was informed that the committee recommended no items for removal.
October 2025	Board approved the removal of one (1) IRI grade 2 spelling item.

Attachment 1: 2026 IRI Assessment Item Review Committee Report by Amira

Presented by The Idaho Department of Education

Prepared by Amira Learning

August 2026

Section 1: Background and Introduction

In accordance with Idaho Code § 33-134 – Assessment Item Review Committee, the Idaho Department of Education (Department) established a review committee intended to ensure that stakeholders of Idaho's public education system (parents, teachers, administrators, and school board members) have the opportunity to review the types of questions that are being used on Idaho state assessments. The law requires that a committee annually review all summative computer adaptive test questions for possible issues of bias and sensitivity.

The committee is authorized to make recommendations to the State Board of Education and the Department regarding the revision or elimination of summative computer adaptive test questions from the state assessments. According to the law, the committee is to consist of at least 30 Idaho residents and shall include the following members from the six regions of Idaho and shall be appointed by the State Board of Education: two parents of public school or public charter school students (12 representatives); one public school or public charter school teacher (6 representatives); one member who is an administrator of a school district or public charter school (6 representatives); and one member from the district board of trustees or public charter school board of directors (6 representatives).

The Department recruited 30 participants from the six regions, adhering to the legislative requirements, to participate in the Assessment Item Review Committee. Committee members are volunteers. Idaho Code § 33-134 states that "no committee member may receive compensation or benefits for the member's service on the committee."

Thirteen participants attended the meeting to review the items on the Idaho Reading Indicator (IRI), an early literacy screener required by Idaho Code § 33-1806. The administration of the IRI is contracted to Amira Learning (Amira) as the sole provider for the State of Idaho. Amira Learning facilitated the bias and sensitivity review committee meeting on August 6, 2026.

On August 6, 2026, Idaho's Assessment Item Review Committee reviewed all 595 new vocabulary items proposed for the Idaho Reading Indicator. Reviewers flagged 35 items

for possible bias or sensitivity and 7 for item-construction concerns - 37 distinct items, since five items drew both kinds of flags. In Round 2, the whole group referred 20 of those items to the State Board of Education for rejection.

Amira is not asking anyone to weigh 20 referrals against 17 close calls. **By Amira Leaning's decision, all 37 flagged items have been removed from the operational pool for the 2026-27 school year - every bias or sensitivity flag, every content flag, whether or not the whole group voted to reject.** When an Idaho teacher, parent, administrator, or trustee says an item may not sit right with a child in their community, that is evidence worth acting on, and the cheapest place to act is before the item reaches a student. The remaining 558 items give every grade a full vocabulary pool, so no student's score depends on an item Idaho educators questioned.

Because every flagged item is withdrawn outright, there is no disputed item left for the State Board of Education to revise or reject. The Department can report the committee's work and the resulting removals as complete, rather than carrying contested items forward for deliberation. All 37 items are already suppressed in the 2026-2027 item bank.

Amira analyzed the effect of the removals on IRI performance and found no risk to the assessment. Three facts explain why:

- **Every reviewed item was new.** None of the 595 items had been administered to Idaho students. Removing them changes no student's prior score, no trend line, and no year-over- year comparison.
- **The pool stays deep.** 558 items remain, with no grade below 87 - ample coverage for the vocabulary subtest at every grade and for the adaptive engine's item selection.
- **Blueprint coverage is intact.** Removals cluster by item type rather than by skill, so no reporting category loses its coverage.

Section 2: Two-Round Review Process

The bias and sensitivity review was completed over the course of one business day. Only new vocabulary items were in scope this year; no other subtests were reviewed. Amira organized the items into two grade- level spans, K-2 and 3-5, and split each span across four review pathways in an online form. Members were randomly assigned to a pathway before the meeting, and every item was read by at least three reviewers.

1. Training- Amira and Department staff covered the statutory charge, Amira's item-development process, the difference between bias and content concerns, and worked examples of items that show bias - followed by a walkthrough of the review form.

2. Round 1- independent review. Reviewers marked each item Approve or Reject against a fairness criteria handout, and every rejection required a written explanation. A single reject flagged the item for Round 2.

3. Round 2 - whole-group discussion. At the end of each grade span, while items were still fresh, flagged items were projected for the full group. The flagging reviewer explained the concern, others responded, and the facilitator called a show-of-hands vote.

4. Determination. A simple majority (7 of 13) referred an item to the State Board for rejection. Items short of a majority stayed in the pool with a note recorded for Amira and Department staff - and it is those notes that Amira has now acted on in full.

Section 3 Results

Committee determinations, K-5

Of 595 items, 560 drew no flag from any reviewer. Flags concentrated in Kindergarten, Grade 1, and Grade 4.

Amira Learning has independently decided to remove all 37 flagged items from its item pool; therefore, no action or decision is required by the Board.

Table 1 • Summary of review committee determinations

Total Items reviewed	K-2	3-5	K-5
Approved by all reviewers (not flagged)	295	300	595
Flagged for bias or sensitivity by at least one reviewer	274	286	560
Of which: whole group upheld rejection	17	3	20
Of which: whole group overruled (approved)	4	11	15
Flagged for content or construction concerns	5	2	7
Distinct items flagged- all removed	21	16	37

Source: Bias & Sensitivity Item Review Summary, August 6, 2026. Five items carried both a bias/sensitivity flag and a content flag, so the distinct total is 37 rather than 42.

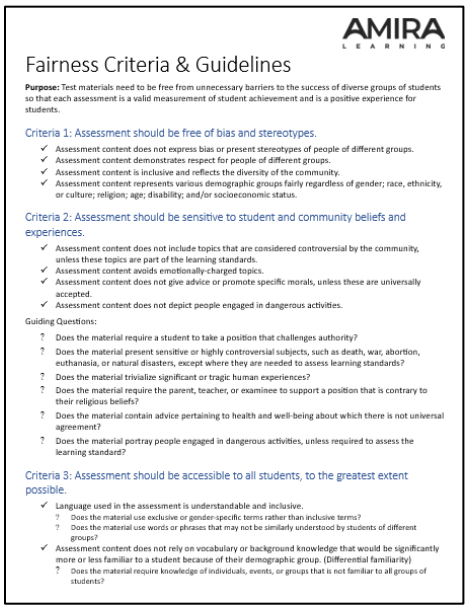
Removals and retained pool, by grade

Removals fall unevenly because concerns clustered by item type: sign-language parity in the early-grade synonym items, and background-knowledge assumptions in the Grade 4 sentence- completion items.

Table 2: Removals and retained pool, by Grade

Grade	Reviewed	Bias/sensitivity flags	Content flags	Removed	Retained
Kindergarten	95	8	3	8	87
Grade 1	100	8	2	8	92
Grade 2	100	5	0	5	95
Grade 3	100	3	1	4	96
Grade 4	100	10	0	10	90
Grade 5	100	1	1	2	98
Total	595	35	7	37	558

Figure 1. Fairness Criteria & Guidelines Handout



AMIRA LEARNING

Fairness Criteria & Guidelines

Purpose: Test materials need to be free from unnecessary barriers to the success of diverse groups of students so that each assessment is a valid measurement of student achievement and is a positive experience for students.

Criteria 1: Assessment should be free of bias and stereotypes.

- ✓ Assessment content does not express bias or present stereotypes of people of different groups.
- ✓ Assessment content demonstrates respect for people of different groups.
- ✓ Assessment content is inclusive and reflects the diversity of the community.
- ✓ Assessment content represents various demographic groups fairly regardless of gender; race, ethnicity, or culture; religion; age; disability; and/or socioeconomic status.

Criteria 2: Assessment should be sensitive to student and community beliefs and experiences.

- ✓ Assessment content does not include topics that are considered controversial by the community, unless these topics are part of the learning standards.
- ✓ Assessment content avoids emotionally-charged topics.
- ✓ Assessment content does not give advice or promote specific morals, unless these are universally accepted.
- ✓ Assessment content does not depict people engaged in dangerous activities.

Guiding Questions:

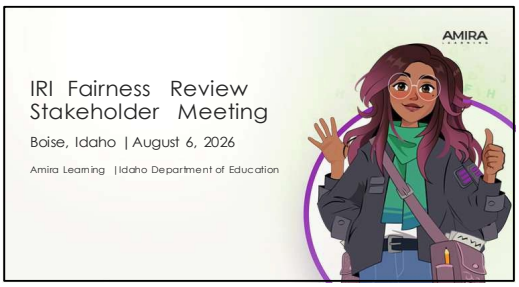
- ? Does the material require a student to take a position that challenges authority?
- ? Does the material present sensitive or highly controversial subjects, such as death, war, abortion, euthanasia, or natural disasters, except where they are needed to assess learning standards?
- ? Does the material trivialize significant or tragic human experiences?
- ? Does the material require the parent, teacher, or examinee to support a position that is contrary to their religious beliefs?
- ? Does the material contain advice pertaining to health and well-being about which there is not universal agreement?
- ? Does the material portray people engaged in dangerous activities, unless required to assess the learning standard?

Criteria 3: Assessment should be accessible to all students, to the greatest extent possible.

- ✓ Language used in the assessment is understandable and inclusive.
  - ? Does the material use exclusive or gender-specific terms rather than inclusive terms?
  - ? Does the material use words or phrases that may not be similarly understood by students of different groups?
- ✓ Assessment content does not rely on vocabulary or background knowledge that would be significantly more or less familiar to a student because of their demographic group. (Differential familiarity)
  - ? Does the material require knowledge of individuals, events, or groups that is not familiar to all groups of students?

Attachment 2: Amira Assessment Item Review Presentation

8/6/2026





Welcome and Thank You

Thank you for volunteering your time to participate in the 2026 Assessment Item Review Committee Meeting.

Support Staff

- Idaho Department of Education Staff
  - Ayaka Nukui (Director)
  - Kacy Proctor (IRI Coordinator)

Background

- Formed by the Idaho Legislature in 2014 through Idaho Code 33-134.
- Last met in fall 2025.
- Second time for IRI

Purpose

- To ensure that statewide assessments measure what they intend to measure (i.e. student's knowledge and skills) by removing questions that could unfairly interfere with student performance.

8/6/2026

Your Role

- To make recommendations to the State Board of Education to revise or eliminate questions that could interfere with student performance.

Statewide Assessments

- Idaho Reading Indicator
- Grades K-3
- Early Literacy Skills- foundational Reading Standards
- Administered in BOY (Beginning of Year) and EOY (End of Year)
- All students (except those that qualify under 33-1618- EL exemption)
- Review is required for K-3, but we will review items for grades 4-5 as well today.

What's Next?

- Training
- Review Items
- Review Items
- Review Items
- ...
- Possibly Virtual Follow-up (if not finished)

Questions?



Contact

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Assessment & Accountability
Idaho State Department of Education
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Amber Van Vooren| ISAT Coordinator
Assessment & Accountability
Idaho State Department of Education
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Preparing for the Review

8/6/2026

Test Security

- Non-disclosure agreements should have already been signed.
- All test materials viewed during this meeting are the intellectual property of Amira Learning and are considered secure and confidential.
- Do NOT discuss test material content outside of this meeting.

Agenda

Time	Agenda Item
8:00 – 8:30	Check In
8:30 – 9:00	System Set Up
9:00 – 9:15	Welcome & Introductions
9:15 – 9:45	Item Review Training
9:45 – 10:30	Item Review - Round 1
10:30 – 10:45	Break
10:45 – 11:30	Item Review - Round 1 (continued)
11:30 – 12:30	Rating Reconciliation & Determinations
12:30 – 1:15	Lunch
1:15 – 2:45	Item Review - Round 2
2:25 – 3:00	Break
3:00 – 3:30	Rating Reconciliation & Determinations
3:30 – 4:00	Final Wrap up
4:00	Adjourn

Steps in the Development Process

Steps in Item Development Process

- Item Development and Pre-Testing
  - Initial item creation aligned to a rigorous blueprint, standards, and learning objectives
  - Review and inclusion of legacy Amira and ISIP assessment item banks
  - Review and Revision
- Pilot Testing
  - Field Testing
  - Data Collection
- Item Validation and Refinement
  - Item fit analysis
  - Item pool creation
  - Continuous monitoring
- Implementation in Computer-Adaptive Testing (CAT)

Fairness Review: What

Assessment Fairness

Purpose: Test materials need to be free from unnecessary barriers to the success of diverse groups of students.

Why?

- Valid measurement of student achievement
- Positive student experience

8/6/2026

Assessment Fairness

Assessment content should be:

- Free of bias and stereotypes
- Sensitive to student and community beliefs and experiences
- Accessible to all students, to the greatest extent possible

Free of Bias and Stereotypes

- Assessment content does not express bias or present stereotypes of people of different groups.
- Assessment content demonstrates respect for people of different groups.
- Assessment content is inclusive and reflects the diversity of the community.

Free of Bias and Stereotypes

- Gender
- Race, Ethnicity, Culture
- Religion
- Age
- Disability
- Socioeconomic

Sensitive to Student and Community Beliefs and Experiences

- Assessment content does not include topics that are considered controversial by the community, unless these topics are part of the learning standards.
- Assessment content avoids emotionally-charged topics.
- Assessment content does not give advice or promote specific morals, unless these are universally accepted.
- Assessment content does not depict people engaged in dangerous activities.

Sensitive to Student and Community Beliefs and Experiences

Does the material:

- Require a student to take a position that challenges authority?
- Present sensitive or highly controversial subjects, such as death, war, abortion, euthanasia, or natural disasters, except where they are needed to assess learning standards?
- Trivialize significant or tragic human experiences?
- Require the parent, teacher, or examinee to support a position that is contrary to their religious beliefs?
- Contain advice pertaining to health and well-being about which there is not universal agreement?
- Portray people engaged in dangerous activities, unless required to assess the learning standard?

Accessible to All Students to the Greatest Extent Possible

Language used in the assessment is understandable and inclusive.

- Does the material use exclusive or gender-specific terms rather than inclusive terms?
- Does the material use words or phrases that may not be similarly understood by students of different groups?

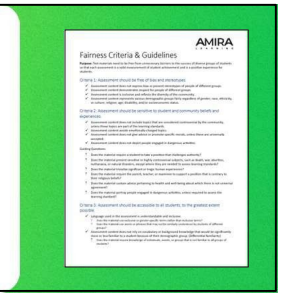
Assessment content does not rely on vocabulary or background knowledge that would be significantly more or less familiar to a student because of their demographic group. (Differential familiarity)

- Does the material require knowledge of individuals, events, or groups that is not familiar to all groups of students?

8/6/2026

Rater Guidelines

- Keep your Fairness Criteria & Guidelines handout close as a reference.
- When in doubt, ask for help.



Flagged Items

- Items flagged for possible bias and sensitivity concern will be reviewed by the whole group.
- The group will vote and decide as a simple majority.
- If a simple majority agrees with the flag, the item will be recommended for removal.
- If a simple majority does not agree with the flag, the item will be flagged for the discretion of the IRI Coordinator to make a determination.



Norms and Participant Guidelines

Participant Guidelines

- Do not record, screenshot, or download specific content.
- After the meeting, destroy any personal notes related to content or phenomenon discussed.
- Do not speak to other panelists about specific passages or items outside of the meeting.
- To limit disruptions, try to take breaks at designated break times.
- If you have any questions about the review or procedures, feel free to ask us.

Questions?

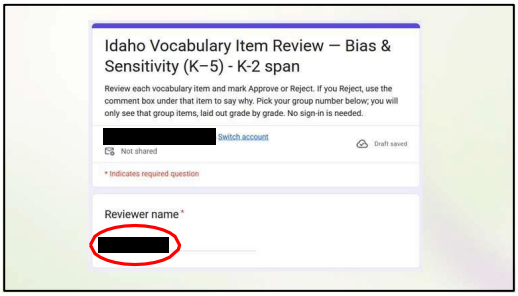
Fairness Review: Let's Begin!

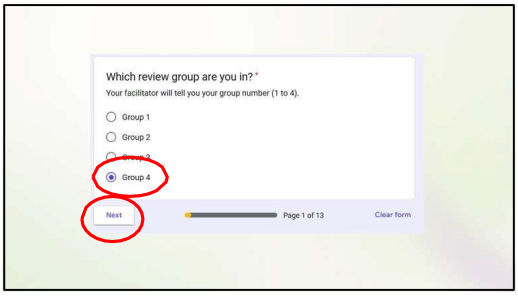
8/6/2026

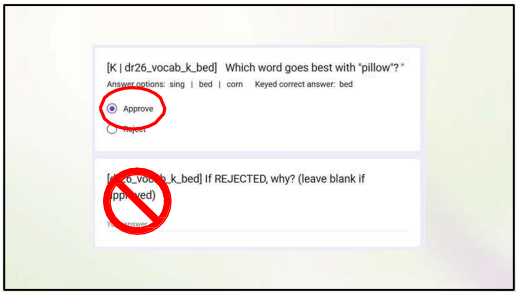
Reviewer Group Assignments

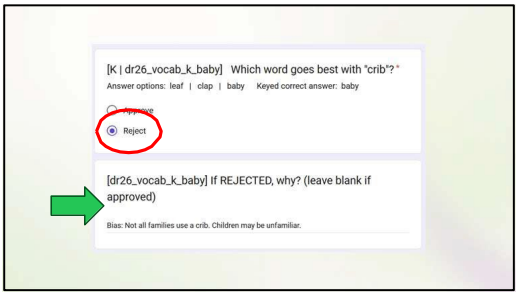
1. Please write down your Reviewer Group Number.
2. Please make sure you are not sitting next to someone in the same group.

First Name	Last Name	Reviewer Group
Alicia	Wheeler	4
Angie	Eldredge	1
Chelsea	lee	3
Darlene	Dyer	4
Joy	Kane	2
Joy	McDaniel	2
Karen	Pyron	1
Lisa	Puckett	4
Mark	Olson	3
Michael	McCormack	2
Peggy	Loutzenhiser	3
Tanya	Koyle	1
Timothy	Hunt	1









Form Design

- 3 "Google Form" pages, 1 per grade level
- About 75 items total per reviewer
- About 25 items per grade level per reviewer
- Choices: Approve or Reject (required questions)

- *If reject*, say why. Ex:
  - Bias: Not all children grow up in homes with cribs, it may not be a common term.
  - Sensitivity: The term "owl" has negative context among some cultures.

8/6/2026

Amira Chromebooks

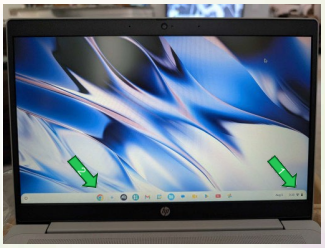
Take out your Chromebook. Please keep packaging materials to return the computers.

Log into your computer. Everyone has the same log-in.

- User Name: AmiraLearningReviewer@gmail.com
- Password: Amira4ID!
- **PIN: 123456**

Please Connect

1. Wi-Fi (bottom right)
2. Google Chrome (bottom left)



Review 3-5 Items

1. Open the Google Form
2. Make sure it says "3-5 Span" at the top
3. Enter your first and last name under "Reviewer Name"
4. Begin
5. If you have questions, ask me.

https://bit.ly/ID26-Amira-35

Item Determinations

- Let's review any items you have flagged.
- If a simple majority agrees with the flag, the item will be recommended for removal.
- If a simple majority does not agree with the flag, the item will be flagged for the discretion of the IRI Coordinator to make a determination

Review K-2 Items

1. Open the Google Form
2. Make sure it says "K-2 Span" at the top
3. Enter your first and last name under "Reviewer Name"
4. Begin
5. If you have questions, ask me.

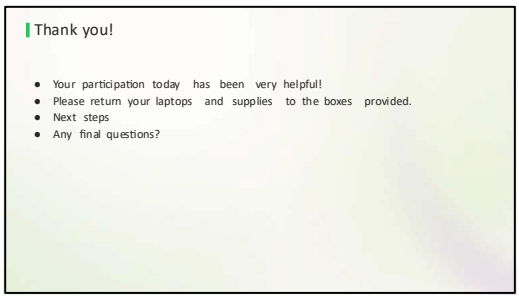
https://bit.ly/ID26-Amira-K2

Item Determinations

- Let's review any items you have flagged.
- If a simple majority agrees with the flag, the item will be recommended for removal.
- If a simple majority does not agree with the flag, the item will be flagged for the discretion of the IRI Coordinator to make a determination

8/6/2026


Wrap Up


Thank you!
Your participation today has been very helpful!
Please return your laptops and supplies to the boxes provided.
Next steps
Any final questions?

8

Attachment 3: 2026 ISAT Assessment Item Review Committee Report by Cambium

IDAHO DEPARTMENT OF EDUCATION

Assessment Item Review Committee Report

August 2026

Section 1: Background and Introduction

In accordance with Idaho Code § 33-134 – Assessment Item Review Committee, Cambium Assessment, Inc. (CAI) and the Idaho Department of Education (Department) established a review committee intended to ensure that stakeholders of Idaho's public education system (parents, teachers, administrators, and school board members) have the opportunity to review the types of questions that are being used on Idaho state assessments. The law requires that a committee annually review all summative computer adaptive test questions for possible issues of bias and sensitivity. The committee is authorized to make recommendations to the State Board of Education and the Department regarding the revision or elimination of summative computer adaptive test questions from the state assessments. According to the law, the committee is to consist of at least 30 Idaho residents and shall include the following members from the six regions of Idaho and shall be appointed by the State Board of Education: two parents of public school or public charter school students; one public school or public charter school teacher; one member who is an administrator of a school district or public charter school; and one member from the district board of trustees or public charter school board of directors. The Department recruited 30 participants from the six regions adhering to the legislative requirements to participate in the Assessment Item Review Committee. Thirteen participants attended the meeting on August 4 and twelve participants attended on August 5.

Section 2: Preparation

Committee members review newly-developed items that will be field tested during the

upcoming Spring ISAT administration. During the August 2026 meeting, committee members reviewed items for the Idaho Standards Achievement Test (ISAT) English Language Arts (ELA)/Literacy, ISAT Math, and ISAT Science. Table 1 shows the number of items that were slated for review.

Table 1: Number of ISAT Items for Review by Content Area

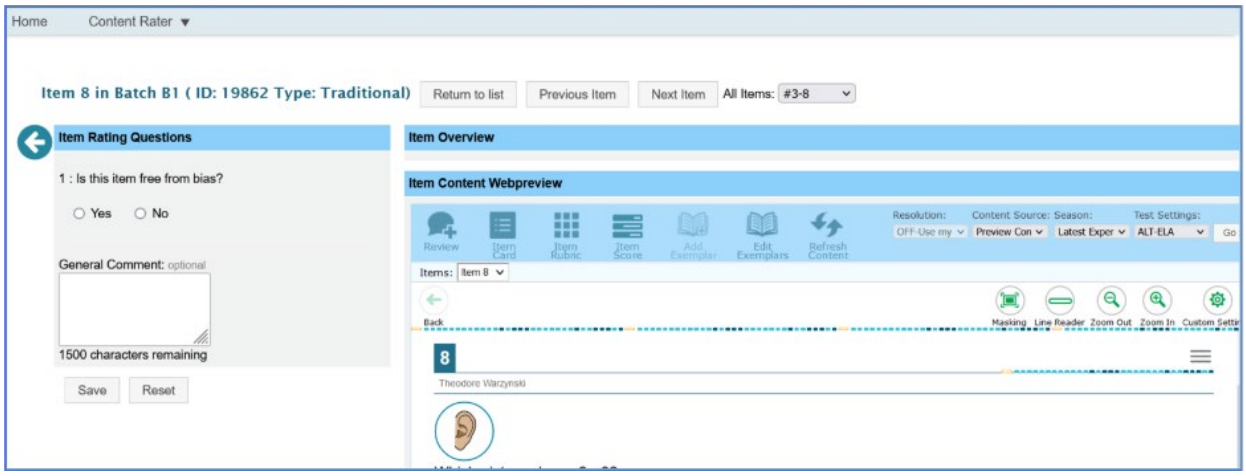
Subject	Total Items for Review
ISAT ELA/LITERACY	61
ISAT MATH	15
ISAT SCIENCE	90
TOTAL	166

For ease of assignment and review by the committee, CAI organized the items into batches by subject. Each of the batches was assigned to every committee member for math and ELA in the first round. In science, there were 3 batches. All participants reviewed 1 of the batches and then half of the participants randomly reviewed one of the other two batches.

CAI configured the Item Tracking System software to create a “Bias and Sensitivity Survey” in its Content Rater application so that committee members could submit electronic feedback about each item in real time. As shown in Figure 1, the user interface for Content Rater displayed each item with a “click-to-enlarge” box that contained the “Item Rating Question” (with comment boxes for feedback); an “Item Overview” dialog pane, which included information about the content alignment of the item; and an “Item Content Web Preview” dialog pane, which presented a rendering of the item as it would appear to a student taking an actual test administration. The Content Rater application contained a single question for the committee to answer: “Bias and Sensitivity: Meets Criteria.” A response of “Yes” or “No” was required for this question on each item that an individual reviewed. If a participant determined that the

item did not meet the Bias and Sensitivity criteria as outlined in the training presentation and as per standing CAI Language Accessibility Bias and Sensitivity (L.A.B.S.) guidelines (i.e., the item **did** display a bias and sensitivity concern), then the panelist would select "No." A "No" response from a committee member would require a comment.

Figure 1. Content Rater Interface



Prior to the committee meeting, CAI created usernames and passwords for each committee member within the Item Tracking System. CAI loaded and randomly pre-assigned batches of items for each committee member to review. Participants were instructed to ask for additional batches as they completed and submitted their initial assignment.

Section 3: Training

Committee members are trained to identify bias and sensitivity concerns in items annually. The "Idaho Assessment Item Review Committee" PowerPoint presentation is included in Appendix 1.

Additionally, the Department provided a training presentation for the participants to learn what they should be looking for when reviewing items. This presentation included the steps in the item development process, information about the difference between bias and content related issues, noted that participants should only be flagging items for bias issues, and provided specific examples of items that may show bias. Upon completion

of the Bias and Sensitivity training, the committee was trained to use the Item Tracking System and Content Rater to submit their feedback on each item electronically (Figure 1).

Section 4: Two-Round Review Process

The Round 1 review process in 2026 was adjusted due to the reduced number of items in this review cycle. Each ISAT item for math and ELA/Literacy were reviewed by every participant. The science items were reviewed by at least half of the participants. As one participant was unable to attend on the day science items were reviewed, there were only 12 participants that day instead of 13. Items “flagged” as displaying bias and sensitivity issues by any reviewers moved on to Round 2 for a large group discussion and review.

Round 2 consisted of a large group discussion where committee members shared their point of view and heard the perspectives and input of other members for each item flagged in Round 1. During the discussion, some items “flagged” were determined to be an issue of content and not bias and sensitivity, and did not end up receiving a vote. After discussion, committee members individually voted if an item met bias and sensitivity criteria. Items for which a majority of the participants voted an item did not meet bias and sensitivity criteria were then moved on to a Round 3 Review conducted by Department staff. If there was a tie, the item was considered to move onto Round 3 review. Participants were allowed to abstain from a vote.

During the Round 3 review process, Department staff reviewed the items with the Department’s executive team. The Department’s executive team then decided which items would be brought forth to the State Board of Education for final determination.

Section 5: 2026 Summary of Committee Review

Round 1 Procedures

After being trained on the item review process, committee members individually reviewed their randomly assigned item batches in the Content Rater Interface. Again, each ISAT ELA/Literacy and ISAT Math item is reviewed by all participants, and each

ISAT science item was reviewed by at least half of the participants. members. Any items flagged as “Rejected” by at least one committee member moved on to Round 2.

Round 1 Results

In the August 2026 meeting, 166 unique items were presented to the committee. The results of the Round 1 review appear in Table 2.

Table 2: Results from Round 1

Subject	Total Items Reviewed	Number of Items Flagged for Round 2 Review
ISAT ELA/Literacy	61	31
ISAT MATHEMATICS	15	12
ISAT SCIENCE	90	9
TOTAL	166	52

Round 2 Procedures

At the beginning of Round 2, committee members participated in a whole group discussion about the items flagged from Round 1. After the discussion, the committee members individually voted on each remaining item. The vote used a simple majority vote rule for identifying items for proposed “Rejected” during Round 2 that should be submitted to the Department for further consideration.

Round 2 Results

The committee members proposed “rejected” or flagged three items as needing further review by the Department. A detailed summary of the results of Round 2 is provided in Table 3.

Table 3: Results from Round 2

Subject	Total Items Reviewed	Number of Items with Zero Flags	Number of Items Flagged for Round 3 Review
ISAT ELA/Literacy	31	29	2
ISAT MATHEMATICS	12	12	0
ISAT SCIENCE	9	8	1
TOTAL	52	49	3

Round 3 Procedures

Upon receiving the proposed items for rejection from the committee after Round 2, Department staff filtered the rejected items by bias and sensitivity concerns versus content concerns. Items with bias and sensitivity concerns that were “Rejected” by a two-thirds supermajority vote from the committee were presented to the Department’s executive team for review. The Department’s executive team then decided which items to send to the State Board of Education for a final determination.

Round 3 Results

The committee members rejected or flagged three items as needing further review by the Department. Upon review by the Department, one item was determined to move onto a final review by the State Board of Education. A detailed summary of the results of Round 3 is provided in Table 4.

Table 3: Results from Round 3

Subject	Total Items Reviewed	Number of Items Flagged for Review by the State Board of Education
ISAT ELA/Literacy	2	0
ISAT MATHEMATICS	0	0
ISAT SCIENCE	1	1
TOTAL	3	1

Section 6. Final Results

Of the 166 items reviewed by the committee per Idaho Code § 33-134, **one item was**

flagged as needing further review by the State Board of Education. A redacted version of the stimulus and item are provided below.

[redacted]

[redacted]

Table 1. [redacted]

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

[redacted]

Table 2 shows the amount of sunshine in each city. The amount of sunshine is measured in hours (hr). The amount of sunshine is not given for the month of March.

Table 2. [redacted]

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Your Task

[redacted]

Part G

[redacted]

Table 4. [redacted]

[redacted]	
[redacted]	
[redacted]	[redacted]

Table 4. [redacted]

[redacted]	
[redacted]	
[redacted]	[redacted]



Implications of Excluding the Flagged Items

CAI has completed the analysis of the impacted Item Bank pools to determine risks associated with rejecting the items identified by the 2026 Assessment Item Review Committee. Based on the State Board of Education's decision in previous years to exclude all items and passages recommended by the Assessment Item Review Committee, Idaho has a separate item configuration for the online delivery of the ELA/L assessments. This requires an annual fee of $57,000 to configure a unique item bank for Idaho. Exclusion of the items proposed by the 2026 Bias and Sensitivity Committee will not incur additional costs by the Idaho State Department of Education.

For additional questions, please contact Ayaka Nukui, Director of Assessment & Accountability, at the Idaho State Department of Education (208-332-6926 or anukui@sde.idaho.gov).

Attachment 4: 2026 ISAT Assessment Item Review Committee Presentation by the Department & Cambium

Idaho Department of Education



Fairness Review Stakeholder meeting

Idaho| August 4-5, 2026

Cambium Assessment, Inc. | Idaho Department of Education

Welcome and Thank You

Thank you for volunteering your time to participate in the 2026 Assessment Item Review Committee Meeting for Bias and Sensitivity.

Support Staff

- Idaho Department of Education Staff
  - Ayaka Nukui (Director)
  - Austin Ambrose (ISAT Coordinator)
  - Kacy Proctor (IRI Coordinator)

3

Background

- Formed by the Idaho Legislature in 2014 through Idaho Code 33-134.
- Last met in August of 2025.

4

Purpose

- To ensure that statewide assessment items measure what they intend to measure (i.e. student's knowledge and skills) by removing questions that could unfairly impact a student's performance due to a bias or sensitive nature of the item.

5

Your Role

- To make recommendations to revise or eliminate questions that could interfere with student performance.
- These recommendations are reviewed by A&A Coordinators & the Department Executive Team
- Any items found for fairness concerns are then referred to the State Board of Education for final decision

6

Statewide Assessments

- Idaho Standards Achievement Test (ISAT)
- Grades 3-8, HS
- English language arts, mathematics, science
- Administered in March-May
- All students (except for those who qualify for IDAA)

7

What's Next?

- Overview on test security
- Training on item review
- Individual item review
- Group discussions
- Facilitated item review
- Possibly Virtual Follow-up (if not finished)

8

Questions?



9

Contact



Austin Ambrose| ISAT Coordinator
Assessment & Accountability
Idaho State Department of Education
208-332-6948 | aambrose@sde.idaho.gov

10

Test Security

- Non-disclosure agreements should have already been signed.
- All test materials viewed during this meeting are considered secure.
- Do NOT discuss test material content outside of this meeting.

11

Agenda – Day 1

Day 1 Meeting Agenda (August 4, 2026)	
8:00 – 8:30	Check In
8:30 – 9:00	System Set Up
9:00 – 9:15	Welcome/Introductions/Overview
9:15 – 9:45	Item Review Training
9:45 – 10:45	Individual Item Review
10:45 – 11:00	Break
11:00 – 11:45	Individual Item Review
11:45 – 12: 45	Lunch
12:45 – 1:00	Group Discussion
1:00 – 2:45	Individual Item Review
2:45 – 3:00	Break
3:00 – 4:00	Facilitated Item Review
4:00	Adjourn

Agenda – Day 2

Day 2 Meeting Agenda (August 5, 2026)	
8:30 – 9:00	Check In/System Set Up
9:00 – 10:45	Individual Item Review
10:45 – 11:00	Break
11:00 – 12:00	Facilitated Item Review
12:00 – 12:15	Closing Remarks
12:15	Adjourn

Steps in the Development Process

Steps in Item Development Process

1. Item development
2. Client review/approval
3. Educator Review (Content & Fairness)
4. **Idaho Stakeholder Review (Fairness)**
5. Field Test with Students
    1. Rubric Validation and Data Review
6. Operational Use

15

Fairness Review Process

Assessment Fairness

Purpose:

Test materials need to be free from unnecessary barriers to the success of diverse groups of students.

Why?

1. Valid measurement of student achievement.
2. Positive student experience.

Assessment Fairness

Assessment content is…

1. free of bias and stereotypes.
2. sensitive to student and community beliefs and experiences.
3. accessible to all students, to the greatest extent possible.

Assessment Fairness

Assessment content is free of bias and stereotypes.

- Assessment content does not express bias or present stereotypes of people of different groups.
- Assessment content demonstrates respect for people of different groups.
- Assessment content is inclusive and reflects the diversity of the community.

Assessment Fairness

Assessment content is free of bias and stereotypes.

- Gender
- Race, Ethnicity, Culture
- Religion
- Age
- Disability
- Socioeconomic

Assessment Fairness

Assessment content is sensitive to student and community beliefs and experiences.

- Assessment content does not include topics that are considered controversial by the community, unless these topics are part of the learning standards.
- Assessment content avoids emotionally-charged topics.
- Assessment content does not give advice or promote specific morals, unless these are universally accepted.
- Assessment content does not depict people engaged in dangerous activities.

Assessment Fairness

Assessment content is sensitive to student and community beliefs and experiences.

- Does the material require a student to take a position that challenges authority?
- Does the material present sensitive or highly controversial subjects, such as death, war, abortion, euthanasia, or natural disasters, except where they are needed to assess learning standards?
- Does the material trivialize significant or tragic human experiences?
- Does the material require the parent, teacher, or examinee to support a position that is contrary to their religious beliefs?
- Does the material contain advice pertaining to health and well-being about which there is not universal agreement?
- Does the material portray people engaged in dangerous activities, unless required to assess the learning standard?

Assessment Fairness

Assessment content is accessible to all students to the greatest extent possible.

Language used in the assessment is understandable and inclusive.

a. Does the material use exclusive or gender-specific terms rather than inclusive terms?
b. Does the material use words or phrases that may not be similarly understood by students of different groups?

Assessment content does not rely on vocabulary or background knowledge that would be significantly more or less familiar to a student because of their demographic group. (Differential familiarity)

a. Does the material require knowledge of individuals, events, or groups that is not familiar to all groups of students?

Fairness Review Process

1. Enter Content Rater system and begin batch.
2. Review each item from a fairness perspective.
    1. Utilize Fairness Criteria Guidelines if needed
    2. Document comments and answers to questions in content rater for discussion
3. Items flagged for possible BNS concern go to Round #2 (group review)

24

Norms and Participant Guidelines

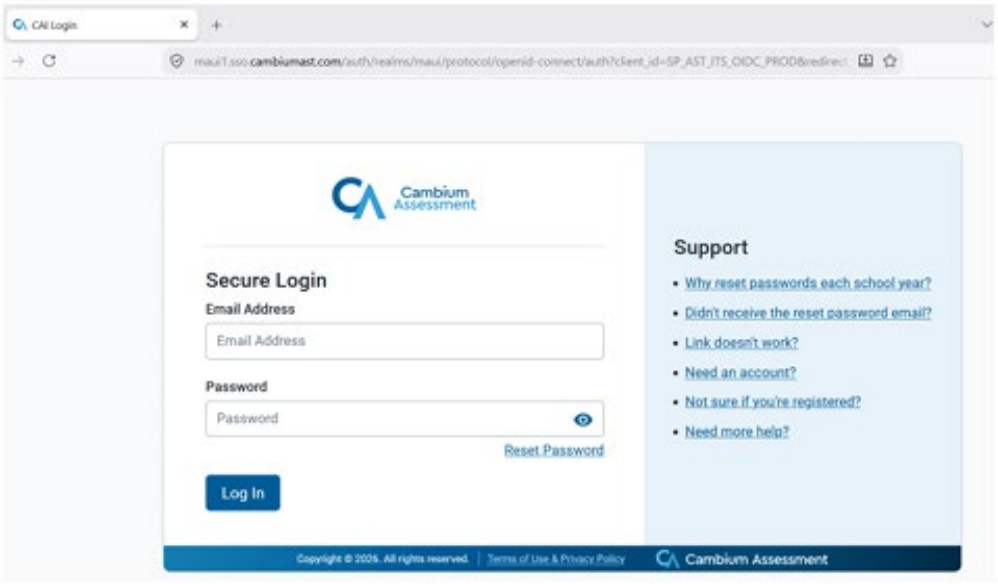
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- Do not speak to other panelists about specific passages or items outside of the meeting.
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- If you have any questions about the review or procedures, feel free to ask the SDE or Cambium staff.

Questions?

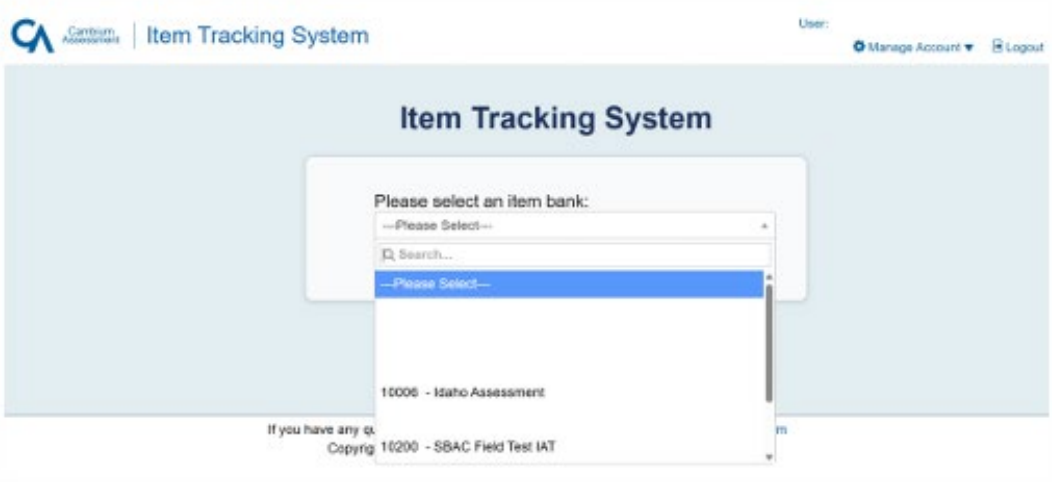
Accessing Content Rater

Accessing Content Rater

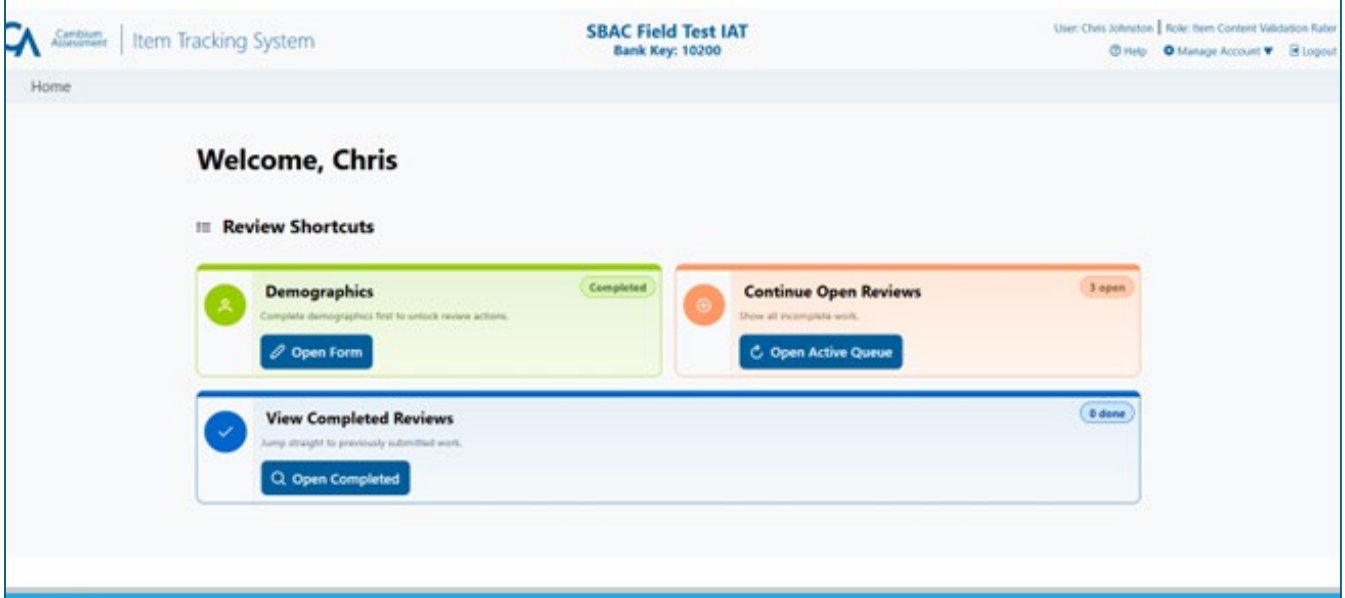


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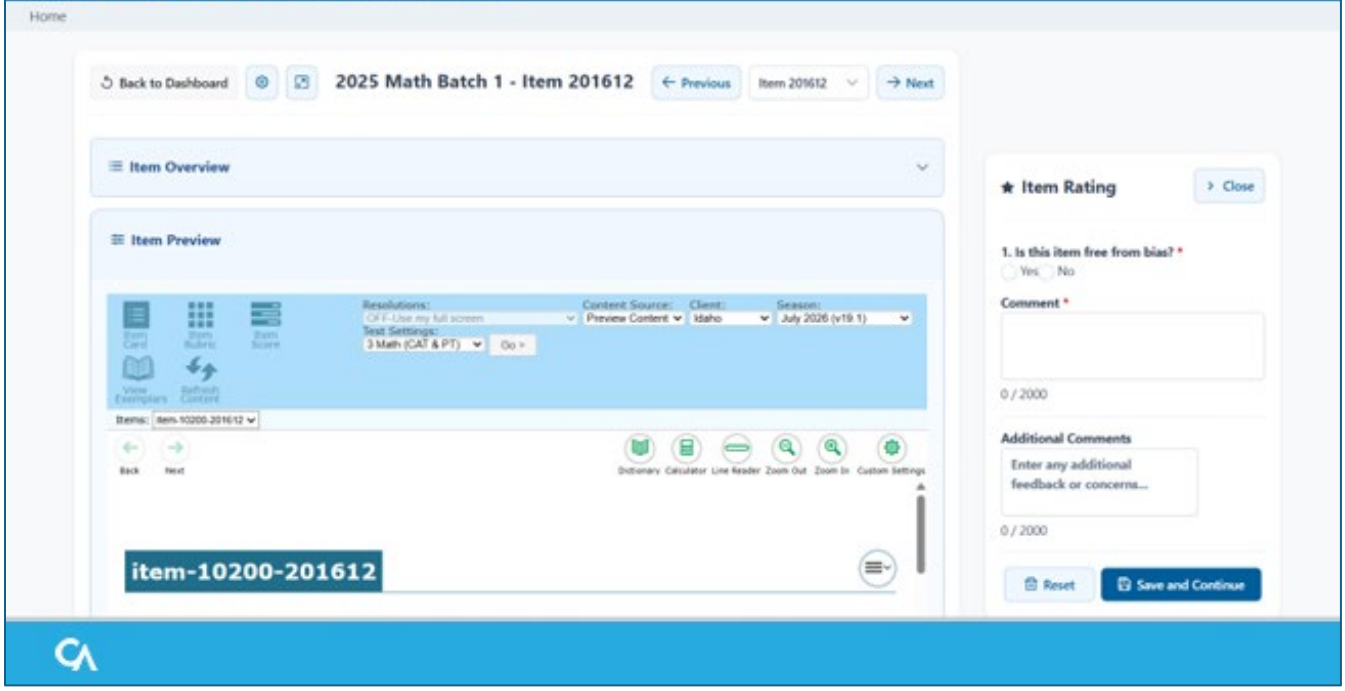
Accessing Content Rater



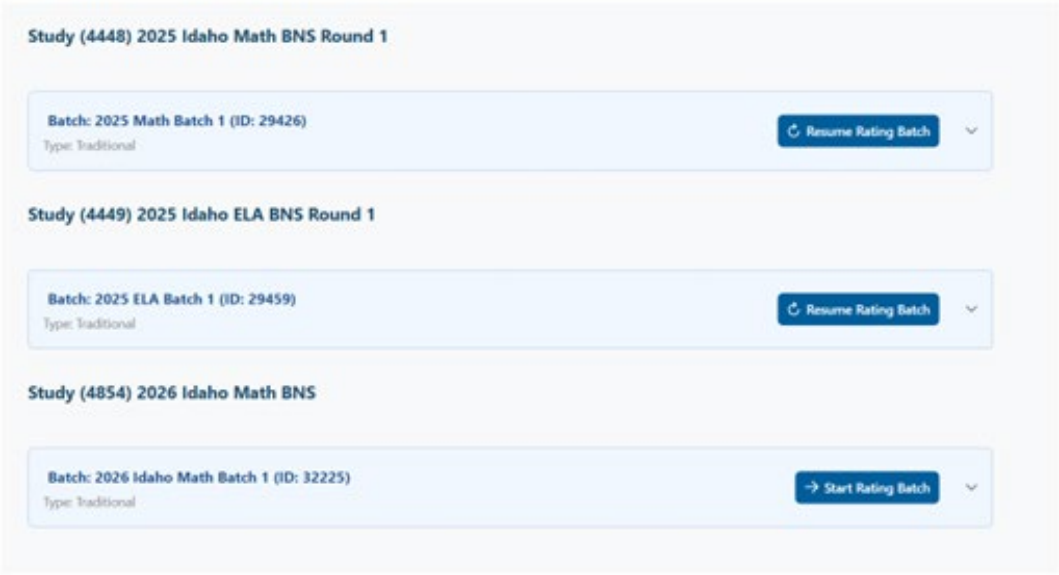
Accessing Content Rater



Accessing Content Rater



Accessing Content Rater



Questions?

Idaho Department of Education

Group Review

Group Review Process

1. Items flagged for concerns are brought to the whole group
2. The individual(s) that flagged the item can share how they see a fairness concern
3. Other committee members can add in additional thoughts regarding the fairness of the item
4. The committee will vote to either:
    a. Keep item as is
    b. Keep item with revisions (if possible and with revisions stated)
    c. Recommend removal due to fairness concerns
5. Majority will confirm action; ties will be considered for removal

Group Review Norms

1. Respect the perspectives of committee members
2. Speak from the "I" perspective
3. Be mindful of the language used in discussions
4. Keep it focused on the item

What's Next

Next Steps

1. Items flagged for concerns are reviewed by the assessment coordinators to check for content versus fairness concern
2. Those with fairness concerns are taken to the Department's executive team for discussion
    a. From here, the final list of items that will be taken to the State Board of Education is decided
3. Cambium and SDE work to create a report that is submitted to the SBOE at their next board meeting
4. The SDE Executive Team present at the next SBOE meeting and the Board makes final determination for the action on the item(s) brought forth

Attachment 5: 2026 Assessment Item Review Expenditure Report

Type of Cost	Cost Incurred
Travel Reimbursements (including per diem)	**$7,158.00**
Hotel Room Costs	$6,494.00
Meeting Room Fee	$1,200.00
Total Hotel Costs	**$7,694.00**
Contract Cost from Amira Learning	**$4,000.00**
Contract Cost from Cambium	**$45,320.00**
TOTAL MEETING COST	**$64,172.00**

Attachment 6: 2026 Assessment Item Review Committee Members and Attendance

Region	First Name	Last Name	Role	Exit Year	Attended 2026 Meeting?
1	Richard	Meyer	Board Member	2027	No
1	Peggy	Loutzenhiser	Administrator	2027	Yes
1	Jennifer	Kelly	Parent	2027	No
1	Tim	Hunt	Parent	2029	Yes
1	Michael	McCormack	Teacher	2029	Yes
2	Alicia	Wheeler	Teacher	2027	Yes
2	Jolyn	Hobson	Administrator	2027	No
3	Lori	Frasure	Board Member	2027	No
3	Allyson	Randall	Teacher	2027	No
3	Tanya	Koyle	Parent	2029	Yes
3	Joy	Kane	Administrator	2027	Yes
4	Charity	Smith	Teacher	2027	No
4	Chelsea	Lee	Parent	2027	Yes
4	Darlene	Dyer	Parent	2029	Yes
5	Angie	Eldredge	Parent	2027	Yes
5	JoDee	Cook	Teacher	2027	No
6	Christina	Fullmer	Teacher	2027	No
6	Lisa	Puckett	Administrator	2027	Yes
6	Mark	Olsen	Parent	2027	Yes
6	Karen	Pyron	Board Member	2027	Yes

Region	First Name	Last Name	Role	Exit Year	Attended 2026 Meeting?
6	Joy	McDaniel	Parent	2027	Yes
4	Sally	Toone	Alternate	--	No
4	Erin	Denney	Alternate	--	No
4	Laree	Jensen	Alternate	--	No

SUBJECT

Science Content Standards Review

BACKGROUND

Idaho Code §33-118B requires the Idaho State Board of Education to review and adopt content standards in English language arts, mathematics, and science within a five-year cycle. The current Idaho Content Standards for Science were adopted in 2022.

In accordance with Idaho Code §33-118B, the Idaho Department of Education convened a Science Standards Review Committee to review the current Idaho Content Standards for Science and determine whether revisions should be recommended as part of the current standards review cycle.

The committee reviewed the existing 2022 Idaho Content Standards for Science and determined that changes to the standards are not necessary at this time, and that any recommendations for revisions could be postponed. The committee's recommendation recognizes the timing of the most recent Science Curricular Materials Review, conducted in 2025. Revising the Science Content Standards shortly after that review could require local education agencies to reevaluate recently adopted curricular materials for alignment with revised standards and could create an unnecessary administrative and financial burden.

Rather than waiting for another full five-year review cycle, the Science Standards Review Committee will reconvene in 2029 to review the standards again and determine which changes are warranted at that time for recommendation.

PROPOSAL

In alignment with the Science Standards Review Committee's recommendation, the Department proposes that the Board adopt the Idaho Content Standards for Science as released in 2022 and provided in Attachment 1 without revision. The Science Standards Review Committee will reconvene in 2029 to conduct an additional thorough review of the standards, with recommended revisions at that time.

IMPACT

Retaining the current 2022 Idaho Content Standards for Science provides continuity for Idaho schools and educators and maintains alignment with the Science Curricular Materials Review conducted in 2025. This approach avoids requiring LEAs to respond to changes in content standards shortly after completing curricular materials review and adoption processes. The planned 2029 review provides an opportunity to reconsider the standards on an accelerated timeline rather than waiting for another full five-year review cycle.

IDE STAFF COMMENTS AND RECOMMENDATIONS

The Idaho Content Standards for Science were substantially changed over a three-year period that led to adoption in 2022 through legislative action, with the standards expiring in Idaho law by July 2027. This process was different from the typical adoption process of standards and this action ensure there is no lapse in Science standards for our schools.

After the 2022 session, implementation of the standards moved forward, with the Science Curricular Materials Review occurring in 2025. Districts are still in the process of ensuring curricular alignment. The Science Standards Review Committee determined no substantial changes to the standards was necessary and additional time with the current standards is necessary before determining if additional changes should be made.

ATTACHMENTS

Attachment 1 – 2026 Idaho Content Standards for Science

BOARD ACTION

I move to adopt the Idaho Content Standards for Science, as written and adopted in 2022 and provided in Attachment 1, as the 2026 Idaho Content Standards for Science, and direct the Idaho State Department of Education to conduct a review of the standards in fiscal year 2029.

Moved by _____ Seconded by _____ Carried Yes _____ No _____

APPLICABLE STATUTE, RULE OR POLICY

Idaho Code § 33-118B
IDAPA 08.02.03

REFERENCE

2022	Current Idaho Content Standards for Science adopted.
2025	Science Curricular Materials review conducted.
2026	Science Standards Review Committee created and reviewed standards.

Idaho Content Standards
Science

~~January 3, 2022~~2026

IDAHO STATE DEPARTMENT OF EDUCATION
CONTENT AND CURRICULUM | SCIENCE

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Table of Contents

Introduction 1
Kindergarten 5
Physical Science 5
Life Science 6
Earth and Space Science 7
Grade 1 9
Physical Science 9
Life Science 10
Earth and Space Science 12
Grade 2 13
Physical Science 13
Life Science 14
Earth and Space Science 14
Grade 3 16
Physical Science 16
Life Science 17
Earth and Space Science 19
Grade 4 20
Physical Science 20
Life Science 22
Earth and Space Science 23
Grade 5 25
Physical Science 25
Life Science 27
Earth and Space Science 29
Middle School 31
Physical Science 31
Life Science 39
Earth and Space Science 46
High School 53
Life Science 53
Physical Science – Chemistry 64
Physical Science – Physics 71
Earth and Space Science 79

Introduction

The Idaho State Content Standards in Science are essential for developing the science literacy of Idaho students, as it is vital that our students understand the fundamental laws and practices within scientific disciplines. This document provides stakeholders with a set of rigorous and relevant science performance standards that prepare students to be informed, contributing citizens of the 21st-century world. The unifying goal is for Idaho students to practice and perform science and use their working knowledge of science to successfully function in a complex world.

The Idaho Science standards describe the knowledge and skills that students should learn, but they do not prescribe particular curricula, lessons, teaching techniques, or activities. Standards describe what students are expected to know and be able to do, while the local curriculum describes how teachers will help students master the standards. A wide variety of instructional resources may be used to meet the state content area standards. Decisions about curriculum and instruction are made locally by individual school districts and classroom teachers. The Idaho State Board of Education does not mandate the curriculum used within local schools. However, these science standards should be taught in a way that allows students to analyze the data and make their own decisions about what it means. Students should also be taught the current models and explanations of the scientific community regarding that data.

Organization and Structure of Science Standards

The Idaho Science Standards are based on *A Framework for K-12 Science Education.*[1] That framework outlines three organizational dimensions for each standard:

- **Science and Engineering Practices**
- **Disciplinary Core Ideas** and **Supporting Content**
- **Crosscutting Concepts**

The **Science and Engineering Practices** are used by students to demonstrate understanding of the disciplinary core ideas and crosscutting concepts. These practices update the scientific method in the classroom and include a wider range of skills for an expanded approach to how scientific investigations are conducted in the real world. Engaging in the practices of science and engineering helps students understand the wide range of approaches used to investigate natural phenomena and develop solutions to challenges. Students are expected to demonstrate grade appropriate proficiency in asking questions and defining problems; developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; constructing explanations and designing solutions; engaging in argument from evidence; and obtaining, evaluating, and communicating information as they gather, analyze, and communicate scientific information.

The **Disciplinary Core Ideas** and **Supporting Content** are the focused, limited set of science ideas identified in the *Framework* as necessary for ALL students throughout their education and beyond their K–12 school years to achieve scientific literacy. The limited number of disciplinary core ideas

[1] National Research Council 2012. *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Washington, DC: The National Academies Press, https://doi.org/10.17226/13165.

allows more time for students and teachers to engage in the science and engineering practices as they deeply explore science ideas. To allow students to continually build on and revise their knowledge and abilities, the disciplinary core ideas are built on developmental learning progressions. In the Idaho State Science Standards, the Disciplinary Core Ideas are incorporated within the Supporting Content for clarity. The Supporting Content defines the minimum boundary of content knowledge needed to fully demonstrate mastery of the standard.

The **Crosscutting Concepts** are used to organize and make sense of disciplinary core ideas. They serve as tools that bridge disciplinary boundaries and deepen understanding of science content. With grade-appropriate proficiency, students are expected to use patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change as they gather, analyze, and communicate scientific understanding. These crosscutting concepts provide structure for synthesizing knowledge from various fields into a coherent and scientifically based view of the world.

The K–12 standards are structured to reflect the developmental nature of learning. Within the standards, content is introduced in a spiraled model using connected core ideas that build deepened understanding throughout grade level progressions. The standards increase in complexity and rigor as students move through the grade levels. Curriculums developed by the school districts of Idaho should encompass all three dimensions of each standard.

The following table lists the disciplinary core ideas, crosscutting concepts, and science and engineering practices (more detailed and grade specific descriptions are available in the supplemental support materials):

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• Asking Questions and Defining Problems • Developing and Using Models • Planning and Carrying Out Investigations • Analyzing and Interpreting Data • Using Mathematics and Computational Thinking • Constructing Explanations and Designing Solutions • Engaging in Argument from Evidence • Obtaining, Evaluating, and Communicating Information	LS1: From Molecules to Organisms: Structures and Processes LS2: Ecosystems: Interactions, Energy, and Dynamics LS3: Heredity: Inheritance and Variation of Traits LS4: Biological Evolution: Unity and Diversity PS1: Matter and Its Interactions PS2: Motion and Stability: Forces and Interactions PS3: Energy PS4: Waves ESS1: Earth's Place in the Universe ESS2: Earth's Systems ESS3: Earth and Human Activity	• Patterns • Cause and Effect • Scale, Proportion, and Quantity • Systems and System Models • Energy and Matter • Structure and Function • Stability and Change

Instructional Shifts

While each standard incorporates the three dimensions, this alone does not drive student outcomes; ultimately, student learning depends on how the standards are translated to instructional practices. In order for students to attain the maximum benefit from the Idaho Science Standards, districts are encouraged to incorporate problem solving techniques and deep critical thinking exercises into those practices. Effective science teaching and learning integrates the three dimensions by allowing students to explain scientific phenomena, design solutions to real-world challenges, and build a foundation upon which they can continue to learn and to apply science knowledge and skills within and outside the K–12 education arena.

Interdisciplinary Approaches

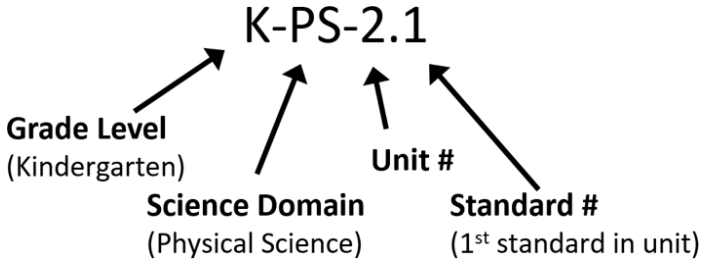
The overlapping skills in the science and engineering practices, combined with the intellectual tools developed by the crosscutting concepts, build meaningful and substantive connections to interdisciplinary knowledge and skills in all content areas. Student understanding and retention are increased as connections are made to interdisciplinary learning which affords all students equitable access to learning and ensures all students are prepared for college, career, and citizenship.

Using This Document

Each standard is followed by the Supporting Content (DCI) in order to add details of what knowledge should be mastered while students are working to achieve each standard. There are often *Further Explanations* and *Assessment Limits* following the content. The *Further Explanations* explain how the concepts embedded within the standard should be emphasized. These often contain examples that are not required, but give guidance about the complexity of ideas to ensure grade appropriate implementation. Assessment limits are similar and do not limit what content is learned about in the classroom, but they do keep assessments from expanding inappropriately outside of the grade-level expectations. These features are included when further clarity is needed.

The coding for each standard labels the grade level, science domain, unit number, and standard number as shown below:

Abbreviations
K – Kindergarten
MS – Middle School
HS – High School
LS – Life Science
ESS – Earth and Space Science
PS – Physical Science
PSC – Physical Science Chemistry
PSP – Physical Science Physics
ETS – Engineering and Technology



Kindergarten

Physical Science

K-PS-1 – Motion and Stability: Forces and Interactions

K-PS-1.1 Students who demonstrate understanding can:
With guidance and support, 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.

Supporting Content PS2.A: Forces and Motion

- Pushes and pulls can have different strengths and directions. (K-PS-1.1, K-PS-1.2)
- Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS-1.1, K-PS-1.2)

Supporting Content PS2.B: Types of Interactions

- When objects touch or collide, they push on one another and can change motion. (K-PS-1.1)

Supporting Content PS3.C: Relationship Between Energy and Forces

- A bigger push or pull makes things speed up or slow down more quickly. (K-PS-1.1)

Further Explanation: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on eachother.

Assessment Limit: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.

K-PS-1.2 Students who demonstrate understanding can:
With guidance and support, analyze data to determine if a design solution works as intended to change the motion of an object with a push or a pull.

Supporting Content PS2.A: Forces and Motion

- Pushes and pulls can have different strengths and directions. (K-PS-1.1, K-PS-1.2)
- Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS-1.1, K-PS-1.2)

Supporting Content ETS1.A: Defining Engineering Problems

- 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. (K-PS-1.2)

Further Explanation: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.

Assessment Limit: Assessment does not include friction as a mechanism for change in speed.

K-PS-2 – Energy

K-PS-S-2.1 Students who demonstrate understanding can:
Make observations to determine the effect of the Sun's energy on the Earth's surface.

Supporting Content PS3.B: Conservation of Energy and Energy Transfer

- Sunlight warms Earth's surface. (K-PS-2.1, K-PS-2.2)

Further Explanation: Examples of Earth's surface could include sand, soil, rocks, and water.

Assessment Limit: Assessment of temperature is limited to relative measures such as warmer/cooler.

K-PS-2.2 Students who demonstrate understanding can:
Design and build a structure that will reduce the warming effect of the Sun's energy on a material.

Supporting Content PS3.B: Conservation of Energy and Energy Transfer

- Sunlight warms Earth's surface. (K-PS-2.1, K-PS-2.2)

Further Explanation: Examples of structures could include umbrellas, canopies, and tents that minimize the warming effect of the Sun on Earth's surface.

Life Science

K-LS-1 – From Molecules to Organisms: Structures and Processes

K-LS-1.1 Students who demonstrate understanding can:
Use observations to describe how plants and animals are alike and different in terms of how they live and grow.

Supporting Content LS1.C: Organization for Matter and Energy Flow in Organisms

- 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. (K-LS-1.1)

Further Explanation: Examples of observations could include that animals need to take in food, but plants produce their own; the different kinds of food needed by different types of animals; the requirement of plants to have light; and that all living things need water.

Earth and Space Science

K-ESS-1 – Earth's Systems

K-ESS-1.1 Students who demonstrate understanding can:
Use and share observations of local weather conditions to describe variations in patterns throughout the year.

Supporting Content ESS2.D: Weather and Climate

- 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 patterns over time. (K-ESS-1.1)
- The four seasons occur in a specific order due to their weather patterns. (K-ESS-1.1)

Further Explanation: Examples of qualitative observations could include descriptions of the weather (such as sunny, cloudy, rainy, and warm); examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month. Examples of patterns could include that it is usually cooler in the morning than in the afternoon and the number of sunny days versus cloudy days in different months.

Assessment Limit: Assessment of quantitative observations limited to whole numbers less than 20 and relative measures such as warmer/cooler.

K-ESS-1.2 Students who demonstrate understanding can:
With guidance and support, use evidence to construct an explanation of how plants and animals interact with their environment to meet their needs.

Supporting Content ESS2.E: Biogeology

- Plants and animals can change their environment. (K-ESS-1.2)

Further Explanation: Examples of plants and animals changing their environment could include a squirrel digging in the ground to hide its food and that tree roots can break concrete.

K-ESS-2 – Weather and Climate

K-ESS-2.1 Students who demonstrate understanding can:
Use a model to represent the relationship between the needs of different plants and animals and the places they live.

Supporting Content ESS3.A: Natural Resources

- Living things need water, air, and resources from the land. They live in places that have the things they need. (K-ESS-2.1)

Further Explanation: Examples of relationships could include that deer eat buds and leaves therefore they usually live in forested areas and grasses need sunlight so they often grow in meadows. Plants, animals, and their surroundings make up a system.

K-ESS-2.2 Students who demonstrate understanding can:
Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, local weather.

Supporting Content ESS3.B: Natural Hazards

- Some kinds of weather are more likely than others in a given region. Weather scientists forecast the weather so that local communities can prepare for and respond to these events. (K-ESS-2.2)

Supporting Content ETS1.A: Delimiting an Engineering Problem

- Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-ESS-2.2)

Further Explanation: Emphasis is on local forms of weather. Examples relating weather forecasting to preparing and responding could include using forecasts to plan for staying indoors during severe weather, going to cooling centers during heat waves, and covering windows before storms.

K-ESS-2.3 Students who demonstrate understanding can:
Communicate ideas that would enable humans to interact in a beneficial way with the land, water, air, and/or other living things in the local environment.

Supporting Content ESS3.C: Human Influences on Earth Systems

- Things that people do can affect the world around them. People can reduce their effects on the land, water, air, and other living things. (K-ESS-2.3)

Supporting Content ETS1.B: Developing Possible Solutions

- 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. (K-ESS-2.3)

Further Explanation: Examples of human influence on the land could include planting trees after a burn, protecting farm fields from erosion, or keeping plastic trash out of waterways.

Grade 1

Physical Science

1-PS-1 – Waves

1-PS-1.1 Students who demonstrate understanding can:
With guidance and support, plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

Supporting Content PS4.A: Wave Properties

- Sound can make matter vibrate, and vibrating matter can make sound. (1-PS-1.1)

Further Explanation: Examples of vibrating materials that make sound could include tuning forks and plucking a stretched string. Examples of how sound can make matter vibrate could include holding a piece of paper near a speaker making sound and holding an object near a vibrating tuning fork.

1-PS-1.2 Students who demonstrate understanding can:
With guidance and support, make observations to construct an evidence-based explanation that objects in darkness can be seen only when illuminated.

Supporting Content PS4.B: Electromagnetic Radiation (light)

- Objects can be seen if light is available to illuminate them or if they give off their own light. (1-PS-1.2)

Further Explanation: Examples of observations could include those made in a completely dark room, a pinhole box, and a video of a cave explorer with a flashlight. Illumination could be from an external light source or by an object giving off its own light.

1-PS-1.3 Students who demonstrate understanding can:
With guidance and support, plan and conduct investigations to determine the effect of placing materials in the path of a beam of light.

Supporting Content PS4.B: Electromagnetic Radiation (light)

- Some materials allow light to pass through them, others allow only some light through, and others block all the light, creating 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.) (1-PS-1.3)

Further Explanation: Examples of materials could include those that are transparent (such as clear plastic), translucent (such as wax paper), opaque (such as cardboard), and reflective (such as a mirror).

Assessment Limit: Assessment does not include the speed of light.

1-PS-1.4 Students who demonstrate understanding can:
Design and build a device that uses light or sound to communicate over a distance.

Supporting Content PS4.C: Information Technologies and Instrumentation

- People also use a variety of devices to communicate (send and receive information) over long distances. (1-PS-1.4)

Further Explanation: Examples of devices could include a light source to send signals, paper cup and string "telephones," and a pattern of drumbeats.

Assessment Limit: Assessment does not include technological details for how communication devices work.

Life Science

1-LS-1 – From Molecules to Organisms: Structures and Processes

1-LS-1.1 Students who demonstrate understanding can:
Design and build 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.

Supporting Content LS1.A: Structure and Function

- 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. (1-LS-1.1)

Supporting Content LS1.D: Information Processing

- 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. (1-LS-1.1)

Further Explanation: Examples of human problems that can be solved by mimicking plant or animal solutions could include: designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and detecting intruders by mimicking eyes and ears.

1-LS-1.2 Students who demonstrate understanding can:
Obtain information to identify patterns of behavior in parents and offspring that help offspring survive.

Supporting Content LS1.B: Growth and Development of Organisms

- Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. (1-LS-1.2)

Further Explanation: Information should be obtained from text readings and media provided by the teacher. Examples of patterns of behaviors could include the signals that offspring make (such as crying, cheeping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).

1-LS-1.3 Students who demonstrate understanding can:
Use classification supported by evidence to differentiate between living and non-living items.

Supporting Content LS1.C: Organization for Matter and Energy Flow in Organisms

- Living and non-living things have distinct characteristics. (1-LS-1.3)

Further Explanation: Use a chart or Venn diagram to sort objects or pictures into living and non-living items.

1-LS-2 – Heredity: Inheritance and Variation of Traits

1-LS-2.1 Students who demonstrate understanding can:
Make observations to construct an evidence-based explanation that offspring are similar to, but not identical to, their parents.

Supporting Content LS3.A: Inheritance of Traits

- Young animals are very much, but not exactly, like their parents. Plants also are very much, but not exactly, like their parents. (1-LS-2.1)

Supporting Content LS3.B: Variation of Traits

- Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (1-LS-2.1)

Further Explanation: Examples of patterns could include features plants or animals share. Examples of observations could include that leaves from the same kind of plant are the same shape but can differ in size, and that a particular breed of dog looks like its parents, but is not exactly the same.

Assessment Limit: Assessment does not include inheritance or animals that undergo metamorphosis or hybrids.

Earth and Space Science

1-ESS-1 – Earth's Place in the Universe

1-ESS-1.1 Students who demonstrate understanding can:
Use observations of the Sun, Moon, and stars to describe patterns that can be predicted.

Supporting Content ESS1.A: The Universe and Its Stars

- Patterns of the motion of the Sun, Moon, and stars in the sky can be observed, described, and predicted. (1-ESS-1.1)

Further Explanation: Examples of patterns could include that the Sun and Moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our Sun are visible at night but not during the day.

Assessment Limit: Assessment of star patterns is limited to stars being seen at night and not during the day.

1-ESS-1.2 Students who demonstrate understanding can:
Make observations at different times of year to relate the amount of daylight to the time of year.

Supporting Content ESS1.B: Earth and the Solar System

- Seasonal patterns of sunrise and sunset can be observed, described, and predicted. (1-ESS-1.2)
- Seasons are created by weather patterns for a particular region and time. Local patterns create four distinct seasons. (1-ESS-1.2)

Further Explanation: Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.

Assessment Limit: Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.

Grade 2

Physical Science

2-PS-1 – Matter and Its Interactions

2-PS-1.1 Students who demonstrate understanding can:
Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

Supporting Content PS1.A: Structure and Properties of Matter

- Different kinds of matter exist and many of them can be solid, liquid, or gas, depending on temperature. Matter can be described and classified by its observable properties. (2-PS-1.1)

Further Explanation: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.

2-PS-1.2 Students who demonstrate understanding can:
Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

Supporting Content PS1.A: Structure and Properties of Matter

- Different properties are suited to different purposes. (2-PS-1.2, 2-PS-1.3)

Further Explanation: Examples of properties could include strength, flexibility, hardness, texture, and absorbency.

Assessment Limit: Assessment of quantitative measurements is limited to length.

2-PS-1.3 Students who demonstrate understanding can:
Make observations to construct an evidence-based argument that objects, when disassembled, may be used to create new objects using the same set of components.

Supporting Content PS1.A: Structure and Properties of Matter

- Different properties are suited to different purposes. (2-PS-1.2, 2-PS-1.3)
- A great variety of objects can be built up from a small set of pieces. (2-PS-1.3)

Further Explanation: Examples of pieces could include blocks, building bricks, or other assorted small objects.

2-PS-1.4 Students who demonstrate understanding can:
Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

Supporting Content PS1.B: Chemical Reactions

- Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS-1.4)

Further Explanation: Examples of reversible changes could include materials such as water and butter at different temperatures. Examples of irreversible changes could include cooking an egg, freezing a plant leaf, and heating paper.

Life Science

2-LS-1 – Ecosystems: Interactions, Energy, and Dynamics

2-LS-1.1 Students who demonstrate understanding can:
Plan and conduct an investigation to determine the impact of light and water on the growth of plants.

Supporting Content LS2.A: Interdependent Relationships in Ecosystems

- Plants depend on water and light to grow. (2-LS-1.1)

Assessment Limit: Assessment is limited to testing one variable at a time.

2-LS-1.2 Students who demonstrate understanding can:
Develop a model that demonstrates how plants depend on animals for pollination or the dispersal of seeds.

Supporting Content LS2.A: Interdependent Relationships in Ecosystems

- Some plants can depend on animals, wind, and water for pollination or to move their seeds around. (2-LS-1.2)

Supporting Content ETS1.B: Developing Possible Solutions

- 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. (2-LS-1.2)

Further Explanation: Emphasis is on the interaction between animals and plants rather than all forms of pollination and seed dispersal.

2-LS-2 – Biological Adaptation: Unity and Diversity

2-LS-2.1 Students who demonstrate understanding can:
Make observations of plants and animals to compare the diversity of life in different habitats.

Supporting Content LS4.D: Biodiversity

- There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS-2.1)

Further Explanation: Emphasis is on the diversity of living things in each of a variety of different habitats.

Assessment Limit: Assessment does not include specific animal and plant names in specific habitats.

Earth and Space Science

2-ESS-1 – Earth's Place in the Universe

2-ESS-1.1 Students who demonstrate understanding can:
Use information from several sources to provide evidence that Earth events can occur quickly or slowly.

Supporting Content ESS1.C: The History of Planet Earth

- Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (2-ESS-1.1)

Further Explanation: Examples of events and timescales could include volcanic explosions and earthquakes, which happen quickly, and erosion of rocks, which occurs slowly.

Assessment Limit: Assessment does not include quantitative measurements of timescales.

2-ESS-2 – Earth's Systems

2-ESS-2.1 Students who demonstrate understanding can:
Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.

Supporting Content ESS2.A: Earth Materials and Systems

- Wind and water can change the shape of the land. (2-ESS-2.1)

Supporting Content ETS1.C: Optimizing the Design Solution

- Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (2-ESS-2.1)

Further Explanation: Examples of solutions could include different designs of dikes and windbreaks to hold back wind and water, and different designs for using shrubs, grass, and trees to hold back the land.

2-ESS-2.2 Students who demonstrate understanding can:
Develop a model to represent the shapes and kinds of land and bodies of water in an area.

Supporting Content ESS2.B: Plate Tectonics and Large-Scale System Interactions

- Maps show where things are located. One can map the shapes and kinds of land and water in any area. (2-ESS-2.2)

Assessment Limit: Assessment does not include quantitative scaling in models.

2-ESS-2.3 Students who demonstrate understanding can:
Obtain information to identify where water is found on Earth and that it can be solid or liquid.

Supporting Content ESS2.C: The Roles of Water in Earth's Surface Processes

- Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form. (2-ESS-2.3)

Grade 3

Physical Science

3-PS-1 – Motion and Stability: Forces and Interactions

3-PS-1.1 Students who demonstrate understanding can:
Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

Supporting Content PS2.A: Forces and Motion

- Each force acts on one particular object with 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, additions of forces are used at this level.) (3-PS-1.1)

Supporting Content PS2.B: Types of Interactions

- Objects in contact exert forces on each other (3-PS-1.1)

Further Explanation: Examples could include that an unbalanced force on one side of a ball can make it start moving; and that balanced forces pushing on a box from both sides will not produce any motion at all.

Assessment Limit: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.

3-PS-1.2 Students who demonstrate understanding can:
Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

Supporting Content PS2.A: Forces and Motion

- Force applied to an object can alter the position and motion of that object: revolve, rotate, float, sink, fall, and at rest. (3-PS-1.2)
- The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS-1.2)

Further Explanation: Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.

Assessment Limit: Assessment does not include technical terms such as period and frequency.

3-PS-1.3 Students who demonstrate understanding can:
Ask questions to determine cause and effect relationships of static electricity or magnetic interactions between two objects not in contact with each other.

Supporting Content PS2.B: Types of Interactions

- 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. For forces between two magnets, the size of the force also depends on their orientation relative to each other. (3-PS-1.3, 3-PS-1.4)

Further Explanation: An example of static electricity force could include the force on hair from an electrically charged balloon. Examples of a magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paper clips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.

Assessment Limit: Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static electricity.

3-PS-1.4 Students who demonstrate understanding can:
Define a problem that can be solved by applying scientific ideas about magnets.

Supporting Content PS2.B: Types of Interactions

- 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. For forces between two magnets, the size of the force also depends on their orientation relative to each other. (3-PS-1.3, 3-PS-1.4)

Further Explanation: Examples of problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.

Life Science

3-LS-1 – From Molecules to Organisms: Structures and Processes

3-LS-1.1 Students who demonstrate understanding can:
Develop models to demonstrate that living things, although they have unique and diverse life cycles, all have birth, growth, reproduction, and death in common.

Supporting Content LS1.B: Growth and Development of Organisms

- Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS-1.1)

Further Explanation: Changes organisms go through during their life form a pattern.

Assessment Limit: Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction.

3-LS-2 – Ecosystems: Interactions, Energy, and Dynamics

3-LS-2.1 Students who demonstrate understanding can:
Construct an argument that some animals form groups that help members survive.

Supporting Content LS2.D: Social Interactions and Group Behavior

- 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. (3-LS-2.1)

3-LS-3 – Heredity: Inheritance and Variation of Traits

3-LS-3.1 Students who demonstrate understanding can:
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.

Supporting Content LS3.A: Inheritance of Traits

- Many characteristics of organisms are inherited from their parents. (3-LS-3.1)

Supporting Content LS3.B: Variation of Traits

- Different organisms vary in how they look and function because they have different inherited information. (3-LS-3.1)

Further Explanation: Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings. Emphasis is on non-human organisms.

Assessment Limit: Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.

3-LS-3.2 Students who demonstrate understanding can:
Use evidence to support the explanation that traits can be influenced by the environment.

Supporting Content LS3.A: Inheritance of Traits

- Many characteristics involve both inheritance and environment. Characteristics result from individuals' interactions with the environment, which can range from diet to learning. (3-LS-3.2)

Supporting Content LS3.B: Variation of Traits

- The environment affects the traits that an organism develops. (3-LS-3.2)

Further Explanation: Examples of the environment affecting a trait could include that normally tall plants grown with insufficient water are stunted, and a pet dog that is given too much food and little exercise may become overweight.

3-LS-3.3 Students who demonstrate understanding can:
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.

Supporting Content LS4.C: Adaptation

- For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (3-LS-3.3)

Further Explanation: Examples of evidence could include needs, characteristics of the organisms, and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.

Earth and Space Science

3-ESS-1 – Earth's Systems

3-ESS-1.1 Students who demonstrate understanding can:
Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.

Supporting Content ESS.D: Weather and Climate

- 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. (3-ESS-1.1)

Further Explanation: Examples of data could include average temperature, precipitation, and wind direction.

Assessment Limit: Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.

3-ESS-1.2 Students who demonstrate understanding can:
Obtain and combine information to describe climates in different regions of the world.

Supporting Content ESS.D: Weather and Climate

- Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years. (3-ESS-1.2)

3-ESS-2 – Earth and Human Activity

3-ESS-2.1 Students who demonstrate understanding can:
Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.

Supporting Content ESS3.B: Natural Hazards

- A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (3-ESS-2.1)

Further Explanation: Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind-resistant roofs, and lightning rods.

Grade 4

Physical Science

4-PS-1 – Energy

4-PS-1.1 Students who demonstrate understanding can:
Use evidence to construct an explanation relating the speed of an object to the energy of that object.

Supporting Content PS3.A: Definitions of Energy

- The faster a given object is moving, the more energy it possesses. (4-PS-1.1)

Assessment Limit: Assessment does not include quantitative measures of changes in the speed of an object or any precise or quantitative definition of energy.

4-PS-1.2 Students who demonstrate understanding can:
Make observations to provide evidence that energy can be transferred by heat, sound, light, and electric currents.

Supporting Content PS3.A: Definitions of Energy

- Energy can be moved from place to place by moving objects or through heat, sound, light, or electric currents. (4-PS-1.2, 4-PS-1.3)

Supporting Content PS3.B: Conservation of Energy and Energy Transfer

- Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (4-PS-1.2, 4-PS-1.3)
- Light transfers energy from place to place. (4-PS-1.2)
- Energy can 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 by transforming the energy of motion into electrical energy. (4-PS-1.2, 4-PS-1.4)

Assessment Limit: Assessment does not include quantitative measurements of energy.

4-PS-1.3 Students who demonstrate understanding can:
Ask questions and predict outcomes about the changes in energy that occur when objects collide.

Supporting Content PS3.A: Definitions of Energy

- Energy can be moved from place to place by moving objects or through heat, sound, light, or electric currents. (4-PS-1.2, 4-PS-1.3)

Supporting Content PS3.B: Conservation of Energy and Energy Transfer

- Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (4-PS-1.2, 4-PS-1.3)

Supporting Content PS3.C: Relationship Between Energy and Forces

- When objects collide, the contact forces transfer energy so as to change the objects' motions. (4-PS-1.3)

Further Explanation: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.

Assessment Limit: Assessment does not include quantitative measurements of energy.

4-PS-1.4 Students who demonstrate understanding can:
Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Supporting Content PS3.B: Conservation of Energy and Energy Transfer

- Energy can 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 by transforming the energy of motion into electrical energy. (4-PS-1.2, 4-PS-1.4)

Supporting Content PS3.D: Energy in Chemical Processes and Everyday Life

- The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. (4-PS-1.4)

Supporting Content ETS1.A: Defining Engineering Problems

- 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. (4-PS-1.4)

Further Explanation: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound, and a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.

Assessment Limit: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.

4-PS-2 – Waves

4-PS-2.1 Students who demonstrate understanding can:
Develop a model of a simple mechanical wave to describe patterns of amplitude and wavelength and that waves can cause objects to move.

Supporting Content PS4.A: Wave Properties

- 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. (4-PS-2.1)
- Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (4-PS-2.1)

Further Explanation: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.

Assessment Limit: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.

4-PS-2.2 Students who demonstrate understanding can:
Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.

Supporting Content PS4.B: Electromagnetic Radiation

- An object can be seen when light reflected from its surface enters the eyes. (4-PS-2.2)

Assessment Limit: Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.

4-PS-2.3 Students who demonstrate understanding can:
Generate and compare multiple solutions that use patterns to transfer information.

Supporting Content PS4.C: Information Technologies and Instrumentation

- 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. (4-PS-2.3)

Supporting Content ETS1.C: Optimizing the Design Solution

- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (4-PS-2.3)

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

Life Science

4-LS-1 – From Molecules to Organisms: Structures and Processes

4-LS-1.1 Students who demonstrate understanding can:
Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Supporting Content LS1.A: Structure and Function

- Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS-1.1)
- Animals have various body systems with specific functions for sustaining life: skeletal, circulatory, respiratory, muscular, digestive, etc. (4-LS-1.1)

Further Explanation: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.

Assessment Limit: Assessment is limited to macroscopic structures within plant and animal systems.

4-LS-1.2 Students who demonstrate understanding can:
Use a model to describe how animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.

Supporting Content LS1.D: Information Processing

- 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. (4-LS-1.2)

Further Explanation: Emphasis is on systems of information transfer.

Assessment Limit: Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.

Earth and Space Science

4-ESS-1 – Earth's Place in the Universe

4-ESS-1.1 Students who demonstrate understanding can:
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.

Supporting Content ESS1.C: The History of Planet Earth

- 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. (4-ESS-1.1)
- There are three classifications of rocks produced within the rock cycle: sedimentary, metamorphic, and igneous. (4-ESS-1.1)

Further Explanation: Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.

Assessment Limit: Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.

4-ESS-2 – Earth's Systems

4-ESS-2.1 Students who demonstrate understanding can:
Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

Supporting Content ESS2.A: Earth Materials and Systems

- 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. (4-ESS-2.1)

Supporting Content ESS2.E: Biogeology

- Living things affect the physical characteristics of their regions. Examples could include a beaver constructing a dam to create a pond or tree roots breaking a rock. (4-ESS-2.1)

Further Explanation: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.

Assessment Limit: Assessment is limited to a single form of weathering or erosion.

4-ESS-2.2 Students who demonstrate understanding can:
Analyze and interpret data from maps to describe patterns of Earth's features.

Supporting Content ESS2.B: Plate Tectonics and Large-Scale System Interactions

- 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 in different areas of Earth. (4-ESS-2.2)

Further Explanation: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.

4-ESS-3 – Earth and Human Activity

4-ESS-3.1 Students who demonstrate understanding can:
Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

Supporting Content ESS3.A: Natural Resources

- Energy and fuels that are modified from natural sources affect the environment in multiple ways. Some resources are renewable over time, and others are not. (4-ESS-3.1)

Further Explanation: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and atomic energy. Examples of environmental effects could include biological effects from moving parts, erosion, change of habitat, and pollution.

4-ESS-3.2 Students who demonstrate understanding can:
Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

Supporting Content ESS3.B: Natural Hazards

- A variety of hazards result from natural processes (e.g., earthquakes, floods, tsunamis, volcanic eruptions). Hazards cannot be eliminated, but their impacts can be reduced. (4-ESS-3.2)

Supporting Content ETS1.B: Designing Solutions to Engineering Problems

- Testing a solution involves investigating how well it performs under a range of likely conditions. (4-ESS-3.2)

Further Explanation: Examples of solutions could include designing an earthquake-resistant building and improving monitoring of volcanic activity.

Assessment Limit: Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.

Grade 5

Physical Science

5-PS-1 – Matter and Its Interactions

5-PS-1.1 Students who demonstrate understanding can:
Develop a model to describe that matter is made of particles too small to be seen.

Supporting Content PS1.A: Structure and Properties of Matter

- 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. (5-PS-1.1)

Further Explanation: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.

Assessment Limit: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.

5-PS-1.2 Students who demonstrate understanding can:
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.

Supporting Content PS1.A: Structure and Properties of Matter

- The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS-1.2)

Supporting Content PS1.B: Chemical Reactions

- 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.) (5-PS-1.2)

Further Explanation: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.

Assessment Limit: Assessment does not include distinguishing mass and weight.

5-PS-1.3 Students who demonstrate understanding can:
Make observations and measurements to identify materials based on their properties.

Supporting Content PS1.A: Structure and Properties of Matter

- 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.) (5-PS-1.3)

Further Explanation: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.

Assessment Limit: Assessment does not include density or distinguishing mass and weight.

5-PS-1.4 Students who demonstrate understanding can:
Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Supporting Content PS1.B: Chemical Reactions

- When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS-1.4)

5-PS-2 – Motion and Stability: Forces and Interactions

5-PS-2.1 Students who demonstrate understanding can:
Support an argument that Earth's gravitational force exerted on objects is directed downward.

Supporting Content PS2.B: Types of Interactions

- The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS-2.1)

Further Explanation: "Downward" is a local description of the direction that points toward the center of the spherical Earth. Examples could include reasoning that since an object that is initially stationary when held moves downward when it is released, there must be a force (gravity) acting on the object that pulls the object toward the center of Earth.

Assessment Limit: Assessment does not include mathematical representation of gravitational force.

5-PS-3 – Energy

5-PS-3.1 Students who demonstrate understanding can:
Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the Sun.

Supporting Content PS3.D: Energy in Chemical Processes and Everyday Life

- The energy released from food was once energy from the Sun. The energy was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS-3.1, *5-LS-1.1*)

Supporting Content LS1.C: Organization for Matter and Energy Flow in Organisms

- 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. (5-PS-3.1)

Further Explanation: Examples of models could include diagrams and flow charts.

Life Science

5-LS-1 – From Molecules to Organisms: Structure and Processes

5-LS-1.1 Students who demonstrate understanding can:
Support an argument that plants get what they need for growth chiefly from air, water, and energy from the Sun.

Supporting Content LS1.C: Organization for Matter and Energy Flow in Organisms

- Plants acquire their material for growth chiefly from air and water. (5-LS-1.1)

Supporting Content PS3.D: Energy in Chemical Processes and Everyday Life

- 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). (5-LS-1.1, *5-PS-3.1*)

Further Explanation: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.

5-LS-2 – Biological Adaptation: Unity and Diversity

5-LS-2.1 Students who demonstrate understanding can:
Analyze and interpret data from fossils to provide evidence of the types of organisms and the environments that existed long ago and compare those to living organisms and their environments.

Supporting Content LS4.A: Evidence of Common Ancestry and Diversity

- Some kinds of plants and animals that once lived on Earth are no longer found anywhere. (5-LS-2.1)
- Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. (5-LS-2.1)

Further Explanation: Examples of data could include type, size, and distributions of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossils found in Arctic areas, and fossils of extinct organisms.

Assessment Limit: Assessment does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.

5-LS-2.2 Students who demonstrate understanding can:
Construct an argument with evidence for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

Supporting Content LS4.B: Natural Selection

- Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing (5-LS-2.2)

Supporting Content LS4.D: Biodiversity

- Populations of animals are classified by their characteristics. (5-LS-2.2)

Further Explanation: Examples of cause and effect relationships could be that plants that have larger thorns than other plants may be less likely to be eaten by predators, and animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.

5-LS-2.3 Students who demonstrate understanding can:
Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals living there may change.

Supporting Content LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- 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. (5-LS-2.3)

Supporting Content LS4.D: Biodiversity

- Populations live in a variety of habitats, and change in those habitats affects the organisms living there. (5-LS-2.3)

Further Explanation: Examples of environmental changes could include changes in land characteristics, water distribution, temperature, food, and other organisms.

Assessment Limit: Assessment is limited to a single environmental change. Assessment does not include the greenhouse effect or climate change.

5-LS-2.4 Students who demonstrate understanding can:
Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Supporting Content LS2.A: Interdependent Relationships in Ecosystems

- 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 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. (5-LS-2.4)

Supporting Content LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- 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. (5-LS-2.4)

Further Explanation: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.

Assessment Limit: Assessment does not include molecular explanations.

Earth and Space Science

5-ESS-1 – Earth's Place in the Universe

5-ESS-1.1 Students who demonstrate understanding can:
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.

Supporting Content ESS1.A: The Universe and Its Stars

- The Sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS-1.1)

Assessment Limit: Assessment is limited to relative distances, not sizes, of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, or stage).

5-ESS-1.2 Students who demonstrate understanding can:
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.

Supporting Content ESS1.B: Earth and the Solar System

- 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. (5-ESS-1.2)

Further Explanation: Examples of patterns could include the position and motion of Earth with respect to the Sun and selected stars that are visible only in particular months.

Assessment Limit: Assessment does not include causes of seasons.

5-ESS-2 – Earth's Systems

5-ESS-2.1 Students who demonstrate understanding can:
Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

Supporting Content ESS2.A: Earth Materials and Systems

- 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. (5-ESS-2.1)

Further Explanation: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.

Assessment Limit: Assessment is limited to the interactions of two systems at a time.

5-ESS-2.2 Students who demonstrate understanding can:
Describe and graph the relative amounts of fresh and salt water in various reservoirs, to interpret and analyze the distribution of water on Earth.

Supporting Content ESS2.C: The Roles of Water in Earth's Processes

- Nearly all of Earth's available water is in the ocean. Most freshwater is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS-2.2)

Assessment Limit: Assessment is limited to oceans, lakes, rivers, glaciers, groundwater, and polar ice caps, and does not include the atmosphere.

5-ESS-3 – Earth and Human Activity

5-ESS-3.1 Students who demonstrate understanding can:
Obtain and combine information about ways communities protect Earth's resources and environment using scientific ideas.

Supporting Content ESS3.C: Human Influences on Earth Systems

- Human activities in agriculture, industry, and everyday life have effects on the land, vegetation, streams, ocean, air, and even outer space. Individuals and communities can often mitigate these effects through innovation and technology. (5-ESS-3.1)

Middle School

Physical Science

MS-PS-1 – Matter and Its Interactions

MS-PS-1.1 Students who demonstrate understanding can:
Develop models to describe the atomic composition of simple molecules.

Supporting Content PS1.A: Structure and Properties of Matter

- 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. (MS-PS-1.1)
- Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS-1.1)

Further Explanation: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of models could include drawings, 3D ball and stick structures, or computer representations.

Assessment Limit: Assessment does not include valence electrons and bonding energy, the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.

MS-PS-1.2 Students who demonstrate understanding can:
Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

Supporting Content PS1.A: Structure and Properties of Matter

- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS-1.2, MS-PS-1.3)

Supporting Content PS1.B: Chemical Reactions

- 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. (MS-PS-1.2, MS-PS-1.3, MS-PS-1.5)

Further Explanation: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.

Assessment Limit: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.

MS-PS-1.3 Students who demonstrate understanding can:
Construct a scientific explanation, based on evidence, to describe that synthetic materials come from natural resources.

Supporting Content PS1.A: Structure and Properties of Matter

- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS-1.2, MS-PS-1.3)

Supporting Content PS1.B: Chemical Reactions

- 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. (MS-PS-1.2, MS-PS-1.3, MS-PS-1.5)

Further Explanation: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, plastics, and alternative fuels.

Assessment Limit: Assessment is limited to qualitative information.

MS-PS-1.4 Students who demonstrate understanding can:
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.

Supporting Content PS1.A: Structure and Properties of Matter

- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS-1.4)
- 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. (MS-PS-1.4)
- The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS-1.4)

Supporting Content PS3.A: Definitions of Energy

- 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. (MS-PS-1.4)
- 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 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. (MS-PS-1.4)

Further Explanation: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.

MS-PS-1.5 Students who demonstrate understanding can:
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.

Supporting Content PS1.B: Chemical Reactions

- 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. (MS-PS-1.2, MS-PS-1.3, MS-PS-1.5)
- The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS-1.5)

Further Explanation: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms.

Assessment Limit: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.

MS-PS-1.6 Students who demonstrate understanding can:
Undertake a design project to construct, test, and/or modify a device that either releases or absorbs thermal energy by chemical processes.

Supporting Content PS1.B: Chemical Reactions

- Some chemical reactions release energy, others store energy. (MS-PS-1.6)

Supporting Content ETS1.B: Developing Possible Solutions

- A solution needs to be tested and then modified on the basis of the test results in order to improve it. (MS-PS-1.6)

Supporting Content ETS1.C: Developing Possible Solutions

- 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. (MS-PS-1.6)
- 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. (MS-PS-1.6)

Further Explanation: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride (i.e., hand-warmers).

Assessment Limit: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.

MS-PS-2 – Motion and Stability: Forces and Interactions

MS-PS-2.1 Students who demonstrate understanding can:
Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

Supporting Content PS2.A: Forces and Motion

- 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). (MS-PS-2.1)

Further Explanation: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.

Assessment Limit: Assessment is limited to vertical or horizontal interactions in one dimension.

MS-PS-2.2 Students who demonstrate understanding can:
Plan and conduct 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.

Supporting Content PS2.A: Forces and Motion

- 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. (MS-PS-2.2)
- 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. (MS-PS-2.2)

Further Explanation: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.

Assessment Limit: Assessment is limited to forces and changes in motion in one dimension in an inertial reference frame and to changes in one variable at a time. Assessment does not include the use of trigonometry.

MS-PS-2.3 Students who demonstrate understanding can:
Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

Supporting Content PS2.B: Types of Interactions

- 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. (MS-PS-2.3)

Further Explanation: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.

Assessment Limit: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.

MS-PS-2.4 Students who demonstrate understanding can:
Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

Supporting Content PS2.B: Types of Interactions

- 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. (MS-PS-2.4)

Further Explanation: Examples of evidence for arguments could include data generated from simulations or digital tools, and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.

Assessment Limit: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.

MS-PS-2.5 Students who demonstrate understanding can:
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.

Supporting Content PS2.B: Types of Interactions

- 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, or a ball, respectively). (MS-PS-2.5)

Further Explanation: Examples of this phenomenon could include the interactions of magnets, electrically charged strips of tape, and electrically charged pith balls. Examples of investigations could include first-hand experiences or simulations.

Assessment Limit: Assessment is limited to electric and magnetic fields, and limited to qualitative evidence for the existence of fields.

MS-PS-3 – Energy

MS-PS-3.1 Students who demonstrate understanding can:
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.

Supporting Content PS3.A: Definitions of Energy

- 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. (MS-PS-3.1)

Further Explanation: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.

MS-PS-3.2 Students who demonstrate understanding can:
Develop a model to describe the relationship between the relative positions of objects interacting at a distance and the relative potential energy in the system.

Supporting Content PS3.A: Definitions of Energy

- A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS-3.2)

Supporting Content PS3.C: Relationship Between Energy and Forces

- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS-3.2)

Further Explanation: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.

Assessment Limit: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.

MS-PS-3.3 Students who demonstrate understanding can:
Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

Supporting Content PS3.A: Definitions of Energy

- Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS-3.3, MS-PS-3.4)

Supporting Content PS3.B: Conservation of Energy and Energy Transfer

- Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS-3.3)

Supporting Content ETS1.A: Defining and Delimiting an Engineering Problem

- 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. (MS-PS-3.3)

Supporting Content ETS1.B: Developing Possible Solutions

- A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (MS-PS-3.3)

Further Explanation: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.

Assessment Limit: Assessment does not include calculating the total amount of thermal energy transferred.

MS-PS-3.4 Students who demonstrate understanding can:
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.

Supporting Content PS3.A: Definitions of Energy

- Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS-3.3, MS-PS-3.4)

Supporting Content PS3.B: Conservation of Energy and Energy Transfer

- The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS-3.4)

Further Explanation: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the final temperature of samples of the same material with different masses when a specific amount of energy is added.

Assessment Limit: Assessment does not include calculating the total amount of thermal energy transferred.

MS-PS-3.5 Students who demonstrate understanding can:
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.

Supporting Content PS3.B: Conservation of Energy and Energy Transfer

- When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS-3.5)

Further Explanation: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.

Assessment Limit: Assessment does not include calculations of energy.

MS-PS-4 – Waves

MS-PS-4.1 Students who demonstrate understanding can:
Use diagrams of a simple wave to explain that (1) a wave has a repeating pattern with a specific amplitude, frequency, and wavelength, and (2) the amplitude of a wave is related to the energy in the wave.

Supporting Content PS4.A: Wave Properties

- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS-4.1)
- Waves transfer energy. (MS-PS-4.1)

Further Explanation: Emphasis is on describing waves with both qualitative and quantitative thinking.

Assessment Limit: Assessment does not include electromagnetic waves and is limited to standard repeating waves.

MS-PS-4.2 Students who demonstrate understanding can:
Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Supporting Content PS4.A: Wave Properties

- A sound wave needs a medium through which it is transmitted. (MS-PS-4.2)

Supporting Content PS4.B: Electromagnetic Radiation

- 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. (MS-PS-4.2)
- 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. (MS-PS-4.2)
- A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS-4.2)
- However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS-4.2)

Further Explanation: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.

Assessment Limit: Assessment is limited to qualitative applications pertaining to light and mechanical waves.

MS-PS-4.3 Students who demonstrate understanding can:
Present qualitative scientific and technical information to support the claim that digitized signals (0s and 1s) can be used to encode and transmit information.

Supporting Content PS4.C: Information Technologies and Instrumentation

- Digitized signals (sent as wave pulses) are a reliable way to encode and transmit information. (MS-PS-4.3)

Further Explanation: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in WIFI devices, and conversion of stored binary patterns to make sound or text on a computer screen.

Assessment Limit: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.

Life Science

MS-LS-1 – From Molecules to Organisms: Structure and Processes

MS-LS-1.1 Students who demonstrate understanding can:
Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.

Supporting Content LS1.A: Structure and Function

- 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). (MS-LS-1.1)

Further Explanation: Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living things, and understanding that living things may be made of one cell or many and varied cells.

MS-LS-1.2 Students who demonstrate understanding can:
Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.

Supporting Content LS1.A: Structure and Function

- Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS-1.2)

Further Explanation: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall. These are visible with a light microscope.

Assessment Limit: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.

MS-LS-1.3 Students who demonstrate understanding can:
Make a claim supported by evidence for how a living organism is a system of interacting subsystems composed of groups of cells.

Supporting Content LS1.A: Structure and Function

- 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. (MS-LS-1.3)

Further Explanation: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems.

Assessment Limit: Assessment does not include the mechanism of one body system independent of others. Assessment is not focused on human body systems.

MS-LS-1.4 Students who demonstrate understanding can:
Construct a scientific argument based on evidence to defend a claim of life for a specific object or organism.

Supporting Content LS1.B: Characteristics of Living Things

- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (MS-LS-1.4)
- Living things share certain characteristics. (These include response to environment, reproduction, energy use, growth and development, life cycles, made of cells, etc.) (MS-LS-1.4)

Further Explanation: Examples should include both biotic and abiotic items, and should be defended using accepted characteristics of life.

Assessment Limit: Assessment does not include specific conclusions regarding the living status of viruses, or other disputed examples.

MS-LS-1.5 Students who demonstrate understanding can:
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.

Supporting Content LS1.C: Organization for Matter and Energy Flow in Organisms

- 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. (MS-LS-1.5)

Further Explanation: Emphasis is on tracing movement of matter and flow of energy.

Assessment Limit: Assessment does not include the biochemical mechanisms of photosynthesis.

MS-LS-1.6 Students who demonstrate understanding can:
Develop a conceptual model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as matter moves through an organism.

Supporting Content LS1.C: Organization for Matter and Energy Flow in Organisms

- Within individual organisms, food moves through a series of chemical reactions (cellular respiration) in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. (MS-LS-1.6)

Further Explanation: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released and on understanding that the elements in the products are the same as the elements in the reactants.

Assessment Limit: Assessment does not include details of the chemical reactions for photosynthesis or respiration.

MS-LS-2 – Ecosystems: Interactions, Energy, and Dynamics

MS-LS-2.1 Students who demonstrate understanding can:
Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

Supporting Content LS2.A: Interdependent Relationships in Ecosystems

- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS-2.1)
- 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. (MS-LS-2.1)
- Growth of organisms and population increases are limited by access to resources. (MS-LS-2.1)

Further Explanation: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.

MS-LS-2.2 Students who demonstrate understanding can:
Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Supporting Content LS2.A: Interdependent Relationships in Ecosystems

- 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. (MS-LS-2.2)

Further Explanation: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.

MS-LS-2.3 Students who demonstrate understanding can:
Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

Supporting Content LS2.B: Cycling of Matter and Energy Transfer in Ecosystems

- Food webs are models that demonstrate how matter and energy is 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. (MS-LS-2.3)

Further Explanation: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.

Assessment Limit: Assessment does not include the use of chemical reactions to describe the processes.

MS-LS-2.4 Students who demonstrate understanding can:
Develop a model to describe the flow of energy through the trophic levels of an ecosystem.

Supporting Content LS2.B: Cycling of Matter and Energy Transfer in Ecosystems

- Food webs can be broken down into multiple energy pyramids. Concepts should include the 10% rule of energy and biomass transfer between trophic levels and the environment. (MS-LS-2.4)

Further Explanation: Emphasis is on describing the transfer of mass and energy, beginning with producers, moving to primary and secondary consumers, and ending with decomposers.

Assessment Limit: Assessment does not include the use of chemical reactions to describe the processes.

MS-LS-2.5 Students who demonstrate understanding can:
Construct an argument supported by evidence that changes to physical or biological components of an ecosystem affect populations.

Supporting Content LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- 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. (MS-LS-2.5)

Further Explanation: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.

MS-LS-2.6 Students who demonstrate understanding can:
Design and evaluate solutions for maintaining biodiversity and ecosystem services.

Supporting Content LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS-2.6)

Supporting Content LS4.D: Biodiversity

- Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (MS-LS-2.6)

Supporting Content ETS1.B: Developing Possible Solutions

- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-LS-2.6)

Further Explanation: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.

MS-LS-3 – Heredity: Inheritance and Variation of Traits

MS-LS-3.1 Students who demonstrate understanding can:
Develop and use a model to describe why mutations may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

Supporting Content LS3.A: Inheritance of Traits

- 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. Structural changes to genes (mutations) can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS-3.1)

Supporting Content LS3.B: Variation of Traits

- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in significant changes to the structure and function of proteins. Changes can be beneficial, harmful, or neutral to the organism. (MS-LS-3.1)

Further Explanation: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.

Assessment Limit: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.

MS-LS-3.2 Students who demonstrate understanding can:
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.

Supporting Content LS1.B: Growth and Development of Organisms

- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (MS-LS-3.2)

Supporting Content LS3.A: Inheritance of Traits

- Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS-3.2)

Supporting Content LS3.B: Variation of Traits

- 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. (MS-LS-3.2)

Further Explanation: Emphasis is on using models such as simple Punnett squares and pedigrees, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.

MS-LS-4 – Biological Adaptation: Unity and Diversity

MS-LS-4.1 Students who demonstrate understanding can:
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.

Supporting Content LS4.A: Classification of Organisms

- The collection of fossils and their placement in chronological order is known as the fossil record and documents the change of many life forms throughout the history of the Earth. Anatomical similarities and differences between various organisms living today and between living and once living organisms in the fossil record enable the classification of living things. (MS-LS-4.1, MS-LS-4.2)

Further Explanation: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.

Assessment Limit: Assessment does not include the names of individual species or geological eras in the fossil record.

MS-LS-4.2 Students who demonstrate understanding can:
Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer relationships.

Supporting Content LS4.A: Classification of Organisms

- The collection of fossils and their placement in chronological order is known as the fossil record and documents the change of many life forms throughout the history of the Earth. Anatomical similarities and differences between various organisms living today and between living and once living organisms in the fossil record enable the classification of living things. (MS-LS-4.1, MS-LS-4.2)

Further Explanation: Emphasis is on explanations of the relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.

MS-LS-4.3 Students who demonstrate understanding can:
Analyze visual evidence to compare patterns of similarities in the anatomical structures across multiple species of similar classification levels to identify relationships.

Supporting Content LS4.A: Classification of Organisms

- Scientific genus and species level names indicate a degree of relationship. (MS-LS-4.3)

Further Explanation: Emphasis is on inferring general patterns of relatedness among structures of different organisms by comparing diagrams, pictures, specimens, or fossils.

Assessment Limit: Assessment of comparisons is limited to gross appearance of anatomical structures within genus and species levels. No memorization of classification levels is required.

MS-LS-4.4 Students who demonstrate understanding can:
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.

Supporting Content LS4.B: Natural Selection

- Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS-4.4)

Further Explanation: Emphasis is on using concepts of natural selection, including overproduction of offspring, passage of time, variation in a population, selection of favorable traits, and heritability of traits.

MS-LS-4.5 Students who demonstrate understanding can:
Obtain, evaluate, and communicate information about how technologies allow humans to influence the inheritance of desired traits in organisms.

Supporting Content LS4.B: Natural Selection

- 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 to offspring. (MS-LS-4.5)

Further Explanation: Emphasis is on identifying and communicating information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy), and on the influence these technologies have on society as well as the technologies leading to these scientific discoveries.

MS-LS-4.6 Students who demonstrate understanding can:
Use mathematical models to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

Supporting Content LS4.C: Adaptation

- 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. (MS-LS-4.6)

Further Explanation: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time. Examples could include Peppered Moth population changes before and after the industrial revolution.

Assessment Limit: Assessment does not include Hardy-Weinberg calculations.

Earth and Space Science

MS-ESS-1 – Earth's Place in the Universe

MS-ESS-1.1 Students who demonstrate understanding can:
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.

Supporting Content ESS1.A: The Universe and Its Stars

- Patterns of the apparent motion of the Sun, the Moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS-1.1)

Supporting Content ESS1.B: Earth and the Solar System

- 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. (MS-ESS-1.1)

Further Explanation: Examples of models can be physical, graphical, or conceptual.

Assessment Limit: Assessment does not include recalling lunar phases.

MS-ESS-1.2 Students who demonstrate understanding can:
Develop and use a model to describe the role of gravity in the orbital motions within galaxies and the solar system.

Supporting Content ESS1.A: The Universe and Its Stars

- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS-1.2)

Supporting Content ESS1.B: Earth and the Solar System

- 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. (MS-ESS-1.2, MS-ESS-1.3)
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS-1.2)

Further Explanation: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state).

Assessment Limit: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.

MS-ESS-1.3 Students who demonstrate understanding can:
Analyze and interpret data to determine scale properties of objects in the solar system.

Supporting Content ESS1.B: Earth and the Solar System

- 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. (MS-ESS-1.2, MS-ESS-1.3)

Further Explanation: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects, such as relative size, distance, motions, and features. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.

Assessment Limit: Assessment does not include recalling facts about properties of the planets and other solar system bodies.

MS-ESS-1.4 Students who demonstrate understanding can:
Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to analyze Earth's history.

Supporting Content ESS1.C: The History of Planet Earth

- The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS-1.4)

Further Explanation: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or large volcanic eruptions.

Assessment Limit: Assessment does not include recalling the names of specific eons, eras, periods or epochs and events within them.

MS-ESS-2 – Earth's Systems

MS-ESS-2.1 Students who demonstrate understanding can:
Develop a model to describe the cycling of Earth's materials and the internal and external flows of energy that drive the rock cycle processes.

Supporting Content ESS2.A: Earth's Materials and Systems

- 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. (MS-ESS-2.1)

Further Explanation: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.

Assessment Limit: Assessment does not include the identification and naming of minerals.

MS-ESS-2.2 Students who demonstrate understanding can:
Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

Supporting Content ESS2.A: Earth's Materials and Systems

- The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS-2.2)

Supporting Content ESS2.C: The Roles of Water in Earth's Surface Processes

- Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. (MS-ESS-2.2)

Further Explanation: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.

Assessment Limit: Assessment does not include memorization of the formation of specific geographic features of Earth's surface, or the geochemical processes involved in the formation.

MS-ESS-2.3 Students who demonstrate understanding can:
Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

Supporting Content ESS1.C: The History of Planet Earth

- Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (MS-ESS-2.3)

Supporting Content ESS2.B: Plate Tectonics and Large-Scale System Interactions

- 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. (MS-ESS-2.3)

Further Explanation: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches). Examples of concepts include continental drift and seafloor spreading.

Assessment Limit: Assessment of plate tectonics should be limited to large-scale system interactions. Paleomagnetic anomalies in oceanic and continental crust are not assessed.

MS-ESS-2.4 Students who demonstrate understanding can:
Develop a model to describe the cycling of water through Earth's systems driven by energy from the Sun and the force of gravity.

Supporting Content ESS2.C: The Roles of Water in Earth's Surface Processes

- Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation, crystallization, percolation, and precipitation, as well as downhill flows on land. (MS-ESS-2.4)
- Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS-2.4)

Further Explanation: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.

Assessment Limit: Assessment includes qualitative energy flows, not quantitative energy calculations.

MS-ESS-2.5 Students who demonstrate understanding can:
Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

Supporting Content ESS2.C: The Roles of Water in Earth's Surface Processes

- 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. (MS-ESS-2.5)

Supporting Content ESS2.D: Weather and Climate

- Because these patterns are so complex, weather can only be predicted using probability. (MS-ESS-2.5)

Further Explanation: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students or obtained through laboratory experiments (such as with condensation and the use of barometers).

Assessment Limit: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.

MS-ESS-2.6 Students who demonstrate understanding can:
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.

Supporting Content ESS2.C: The Roles of Water in Earth's Surface Processes

- Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS-2.6)

Supporting Content ESS2.D: Weather and Climate

- 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. (MS-ESS-2.6)
- 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. (MS-ESS-2.6)

Further Explanation: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.

Assessment Limit: Assessment does not include the dynamics of the Coriolis effect, or recalling names and locations of specific biomes.

MS-ESS-3 – Earth and Human Activity

MS-ESS-3.1 Students who demonstrate understanding can:
Construct a scientific explanation based on evidence for how Earth's mineral, energy, and groundwater resources are unevenly distributed as a result of past and current geologic processes.

Supporting Content ESS3.A: Natural Resources

- 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. (MS-ESS-3.1)

Further Explanation: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are changing as a result of depletion. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).

MS-ESS-3.2 Students who demonstrate understanding can:
Analyze and interpret data on natural hazards to forecast future catastrophic events to mitigate their effects.

Supporting Content ESS3.B: Natural Hazards

- 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. (MS-ESS-3.2)

Further Explanation: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions. Others, such as earthquakes, occur suddenly, and are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of mitigation strategies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).

MS-ESS-3.3 Students who demonstrate understanding can:
Apply scientific practices to design a method for monitoring human activity and increasing beneficial human influences on the environment.

Supporting Content ESS3.C: Human Influences on Earth Systems

- Human activities can positively and negatively influence the biosphere, sometimes altering natural habitats and ecosystems. (MS-ESS-3.3)
- Technology and engineering can potentially help us best manage natural resources as populations increase. (MS-ESS-3.3, MS-ESS-3.4)

Further Explanation: Examples of the design process include examining human interactions and designing feasible solutions that promote stewardship. Examples can include water usage (such as stream and river use, aquifer recharge, or dams and levee construction); land usage (such as urban development, agriculture, wetland benefits, stream reclamation, or fire restoration); and pollution (such as of the air, water, or land).

MS-ESS-3.4 Students who demonstrate understanding can:
Construct an argument based on evidence for how changes in human population and per-capita consumption of natural resources positively and negatively affect Earth's systems.

Supporting Content ESS3.C: Human Influences on Earth Systems

- Technology and engineering can potentially help us best manage natural resources as populations increase. (MS-ESS-3.3, MS-ESS-3.4)

Further Explanation: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of effects can include changes made to the appearance, composition, and structure of Earth's systems as well as the rates at which they change.

MS-ESS-3.5 Students who demonstrate understanding can:
Ask questions to interpret evidence of the factors that cause climate variability throughout Earth's history.

Supporting Content ESS3.C: Human Influences on Earth Systems

- Current scientific models indicate that human activities, such as the release of greenhouse gases from fossil fuel combustion, can contribute to the present-day measured rise in Earth's mean surface temperature. Natural activities, such as changes in incoming solar radiation, also contribute to changing global temperatures. (MS-ESS-3.5)

Further Explanation: Examples of factors include human activities (such as fossil fuel combustion and changes in land use) and natural processes (such as changes in incoming solar radiation and volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures; atmospheric levels of gases such as carbon dioxide and methane; and natural resource use.

High School

Life Science

HS-LS-1 – From Molecules to Organisms: Structures and Processes

HS-LS-1.1 Students who demonstrate understanding can:
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.

Supporting Content LS1.A: Structure and Function

- Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS-1.1)
- 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. (HS-LS-1.1, HS-LS-3.1)

Further Explanation: Emphasis is on the structure of the double helix, the pairing and sequencing of the nitrogenous bases, transcription, translation, and protein synthesis.

Assessment Limit: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.

HS-LS-1.2 Students who demonstrate understanding can:
Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Supporting Content LS1.A: Structure and Function

- 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. (HS-LS-1.2)

Further Explanation: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.

Assessment Limit: Assessment does not include interactions and functions at the molecular or chemical reaction level.

HS-LS-1.3 Students who demonstrate understanding can:
Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Supporting Content LS1.A: Structure and Function

- Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS-1.3)

Further Explanation: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.

Assessment Limit: Assessment does not include the cellular processes involved in the feedback mechanism.

HS-LS-1.4 Students who demonstrate understanding can:
Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

Supporting Content LS1.B: Growth and Development of Organisms

- 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. (HS-LS-1.4)

Assessment Limit: Assessment does not include specific gene control mechanisms.

HS-LS-1.5 Students who demonstrate understanding can:
Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

Supporting Content LS1.C: Organization for Matter and Energy Flow in Organisms

- The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS-1.5)

Further Explanation: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.

Assessment Limit: Assessment does not include specific biochemical steps.

HS-LS-1.6 Students who demonstrate understanding can:
Construct 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.

Supporting Content LS1.C: Organization for Matter and Energy Flow in Organisms

- Sugar molecules contain carbon, hydrogen, and oxygen; their hydrocarbon backbones combined with nitrogen, sulfur and/or phosphorous are used to make monomers (amino acids) and other carbon-based molecules that can be assembled into larger macromolecules (such as proteins or DNA), used for example to form new cells. (HS-LS-1.6)
- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS-1.6, HS-LS-1.7)

Further Explanation: Emphasis is on using evidence from models and simulations to support explanations.

Assessment Limit: Assessment does not include the details of the specific chemical reactions or identification of macromolecules.

HS-LS-1.7 Students who demonstrate understanding can:
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.

Supporting Content LS1.C: Organization for Matter and Energy Flow in Organisms

- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS-1.6, HS-LS-1.7)
- 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 cells. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS-1.7)

Further Explanation: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.

Assessment Limit: Assessment should not include identification of the steps or specific processes involved in cellular respiration.

HS-LS-2 – Ecosystems: Interactions, Energy, and Dynamics

HS-LS-2.1 Students who demonstrate understanding can:
Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

Supporting Content LS2.A: Interdependent Relationships in Ecosystems

- 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 such 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. (HS-LS-2.1, HS-LS-2.2)

Further Explanation: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.

Assessment Limit: Assessment does not include deriving mathematical equations to make comparisons.

HS-LS-2.2 Students who demonstrate understanding can:
Use mathematical representations to support explanations that biotic and abiotic factors affect biodiversity at different scales within an ecosystem.

Supporting Content LS2.A: Interdependent Relationships in Ecosystems

- 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 such 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. (HS-LS-2.1, HS-LS-2.2)

Supporting Content LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- 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. (HS-LS-2.2, HS-LS-2.5)

Further Explanation: Emphasis is on genetic diversity within a population and species diversity within an ecosystem. Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.

Assessment Limit: Assessment is limited to provided data.

HS-LS-2.3 Students who demonstrate understanding can:
Construct an explanation using mathematical representations to support claims for the flow of energy through trophic levels and the cycling of matter in an ecosystem.

Supporting Content LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS-2.3, HS-LS-2.4)
- Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS-2.3)

Further Explanation: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.

Assessment Limit: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.

HS-LS-2.4 Students who demonstrate understanding can:
Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

Supporting Content LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- 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, geological, and biological processes. (HS-LS-2.4)
- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS-2.3, HS-LS-2.4)

Further Explanation: Examples of models could include simulations and mathematical models.

Assessment Limit: Assessment does not include the specific chemical steps of photosynthesis and respiration.

HS-LS-2.5 Students who demonstrate understanding can:
Evaluate the claims, evidence, and reasoning that changing the conditions of a static ecosystem may result in a new ecosystem.

Supporting Content LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- 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. (HS-LS-2.2, HS-LS-2.5)

Further Explanation: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as a seasonal flood, and extreme changes, such as volcanic eruption or sea level rise.

HS-LS-2.6 Students who demonstrate understanding can:
Design, evaluate, and/or refine practices used to manage a natural resource based on direct and indirect influences of human activities on biodiversity and ecosystem health.

Supporting Content LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Changes in the environment, including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate variability, can disrupt an ecosystem and threaten the survival of some species. (HS-LS-2.6)

Supporting Content LS4.C: Adaptation

- Changes in the physical environment have contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline or possible extinction of some species. (HS-LS-2.6, HS-LS-4.5)

Supporting Content LS4.D: Biodiversity

- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (HS-LS-2.6)
- Sustaining ecosystem health and biodiversity is essential to support and enhance life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational, cultural, or inspirational value. Humans depend on the living world for the resources and other benefits provided by biodiversity. Effects on biodiversity can be mitigated through actions such as habitat conservation, reclamation practices, wildlife management, and invasive species control. Understanding the effects of population growth, wildfire, pollution, and climate variability on changes in biodiversity could help maintain the integrity of biological systems. (HS-LS-2.6)

Supporting Content ESS3.A: Natural Resources

- Resource availability has guided the development of human society. (HS-LS-2.6, *HS-ESS-3.1*)

Supporting Content ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, environmental, and cultural impacts. (HS-LS-2.6)

Further Explanation: Emphasis is on how natural resources such as forests, waterways, and land are managed in ways that minimize harm to biodiversity and ecosystem health and activities that can improve and or maintain existing health of ecosystems.

HS-LS-2.7 Students who demonstrate understanding can:
Evaluate the evidence for the role of group behavior on individual and species' ability to survive and reproduce.

Supporting Content LS2.D: Social Interactions and Group Behavior

- Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS-2.7)

Further Explanation: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.

HS-LS-3 – Heredity: Inheritance and Variation of Traits

HS-LS-3.1 Students who demonstrate understanding can:
Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

Supporting Content LS1.A: Structure and Function

- 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. (HS-LS-1.1, HS-LS-3.1)

Supporting Content LS2.A: Inheritance of Traits

- 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. (HS-LS-3.1)

Assessment Limit: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.

HS-LS-3.2 Students who demonstrate understanding can:
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.

Supporting Content LS3.B: Variation of Traits

- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis, 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. (HS-LS-3.2)
- 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. (HS-LS-3.2, HS-LS-3.3)

Further Explanation: Emphasis is on using data to support claims about the way variation occurs.

Assessment Limit: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.

HS-LS-3.3 Students who demonstrate understanding can:
Apply concepts of probability and statistical analysis to explain the variation and distribution of expressed traits in a population.

Supporting Content LS3.B: Variation of Traits

- 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. (HS-LS-3.2, HS-LS-3.3)

Further Explanation: Emphasis is on the use of mathematics to describe the probability of traits (alleles) as it relates to genetic and environmental factors in the expression of traits.

Assessment Limit: Assessment does not include Hardy-Weinberg calculations.

HS-LS-4 – Biological Adaptation: Unity and Diversity

HS-LS-4.1 Students who demonstrate understanding can:
Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

Supporting Content LS4.A: Evidence of Common Ancestry and Diversity

- Genetic information, like the fossil record, provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information can be derived from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS-4.1)

Further Explanation: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development.

HS-LS-4.2 Students who demonstrate understanding can:
Construct an explanation based on evidence that the process of evolution, through the mechanism of natural selection, 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.

Supporting Content LS4.B: Natural Selection

- 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. (HS-LS-4.2, HS-LS-4.3)

Supporting Content LS4.C: Adaptation

- Evolution is a consequence of the interaction of four factors of natural selection: (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. (HS-LS-4.2)

Further Explanation: Emphasis is on using evidence to explain the influence each of the four factors has on the number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.

Assessment Limit: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.

HS-LS-4.3 Students who demonstrate understanding can:
Apply concepts of probability and statistical analysis to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

Supporting Content LS4.B: Natural Selection

- 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. (HS-LS-4.2, HS-LS-4.3)
- The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS-4.3)

Supporting Content LS4.C: Adaptation

- 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. (HS-LS-4.3, HS-LS-4.4)
- Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS-4.3)

Further Explanation: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.

Assessment Limit: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.

HS-LS-4.4 Students who demonstrate understanding can:
Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Supporting Content LS4.C: Adaptation

- 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. 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. (HS-LS-4.3, HS-LS-4.4)

Further Explanation: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.

HS-LS-4.5 Students who demonstrate understanding can:
Evaluate models that demonstrate how changes in an environment may result in the evolution of a population of a given species; the emergence of new species over generations; or the extinction of other species due to the processes of genetic drift, gene flow, mutation, and natural selection.

Supporting Content LS4.C: Adaptation

- Changes in the physical environment have contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline or possible extinction of some species. (HS-LS-2.6, HS-LS-4.5)
- Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS-4.5)

Further Explanation: Emphasis is on determining cause and effect relationships for how changes to the environment such as drought, flood, fire, deforestation, overfishing, application of fertilizers and pesticides, and the rate of change of the environment affect the distribution or disappearance of traits in species.

Physical Science – Chemistry

HS-PSC-1 – Structure and Properties of Matter

HS-PSC-1.1 Students who demonstrate understanding can:
Develop models to describe the atomic composition of simple molecules and extended structures.

Supporting Content PS1.A: Structure and Properties of Matter

- 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. (HS-PSC-1.1)

Further Explanation: Emphasis is on reviewing how to develop models of molecules that vary in complexity. This should build on the similar middle school standard (MS-PS-1.1). Students should be able to determine valence electrons for representative elements. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of models could include drawings, 3D ball and stick structures, or computer representations.

Assessment Limit: Students will be provided with the names of the elements, a list of common ions, a list of numerical prefixes and their meanings, and the charges of all cations and anions.

HS-PSC-1.2 Students who demonstrate understanding can:
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.

Supporting Content PS1.A: Structure and Properties of Matter

- Each atom has a substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PSC-1.2)
- 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 outermost electron states. (HS-PSC-1.2)

Further Explanation: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.

Assessment Limit: Assessment is limited to main group elements. Assessment is limited to relative trends in reactivity, valence electrons, atomic and ionic radius, electronegativity, ionization energy, shielding effect, and common oxidation number.

HS-PSC-1.3 Students who demonstrate understanding can:
Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrostatic forces between particles.

Supporting Content PS1.A: Structure and Properties of Matter

- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PSC-1.3, HS-PSC-1.5)

Supporting Content PS2.B: Types of Interactions

- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties (physical and chemical), and transformations of matter, as well as the contact forces between material objects. (HS-PSC-1.3, HS-PSC-1.5, *HS-PSP-1.6*)

Further Explanation: Emphasis is on understanding the strengths of forces between particles. Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.

Assessment Limit: Assessment does not include naming specific intermolecular forces (such as dipole-dipole). Assessment will be limited to quantitative calculations of melting and boiling points only.

HS-PSC-1.4 Students who demonstrate understanding can:
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 the various modes of radioactive decay.

Supporting Content PS1.C: Nuclear Processes

- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS-PSC-1.4)

Further Explanation: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.

Assessment Limit: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma modes of radioactive decay.

HS-PSC-1.5 Students who demonstrate understanding can:
Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Supporting Content PS1.A: Structure and Properties of Matter

- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PSC-1.3, HS-PSC-1.5)

Supporting Content PS2.B: Types of Interactions

- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties (physical and chemical), and transformations of matter, as well as the contact forces between material objects. (HS-PSC-1.3, HS-PSC-1.5, *HS-PSP-1.6*)

Further Explanation: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.

Assessment Limit: Assessment is limited to provided molecular structures of specific designed materials. For questions involving polar vs. nonpolar bonds, item distractors containing ionic bonds may not be used. Electronegativity differences of < 0.5 should be used for nonpolar covalent bonds. Electronegativity differences of 0.5 – 1.7 should be used for polar covalent bonds.

HS-PSC-2 – Chemical Reactions

HS-PSC-2.1 Students who demonstrate understanding can:
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.

Supporting Content PS1.A: Structure and Properties of Matter

- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar physical and chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PSC-2.1)

Supporting Content PS1.B: Chemical Reactions

- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PSC-2.1, HS-PSC-2.4)

Further Explanation: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.

Assessment Limit: Assessment is limited to synthesis, decomposition, single replacement/displacement, double replacement/displacement—including neutralization—and combustion reactions. Predict the products of double replacement, single replacement, and combustion reactions only. Assessment excludes writing formulas or names of acids and hydrocarbons.

HS-PSC-2.2 Students who demonstrate understanding can:
Develop a model to illustrate that the energy transferred during an exothermic or endothermic chemical reaction is based on the bond energy difference between bonds broken (absorption of energy) and bonds formed (release of energy).

Supporting Content PS1.A: Structure and Properties of Matter

- A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PSC-2.2)

Supporting Content PS1.B: Chemical Reactions

- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PSC-2.2, HS-PSC-2.3)

Further Explanation: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.

Assessment Limit: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.

HS-PSC-2.3 Students who demonstrate understanding can:
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.

Supporting Content PS1.B: Chemical Reactions

- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PSC-2.2, HS-PSC-2.3)

Further Explanation: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.

Assessment Limit: Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.

HS-PSC-2.4 Students who demonstrate understanding can:
Use mathematical representations to support the claim that the number and type of atoms, and therefore mass, are conserved during a chemical reaction.

Supporting Content PS1.B: Chemical Reactions

- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PSC-2.1, HS-PSC-2.4)

Further Explanation: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.

Assessment Limit: Conversion problems will be one to two steps (e.g., grams to moles to atoms/molecules). Compounds and formulas should be provided in the stem of the question. Students should be given molecular masses in problems involving gram to other unit conversions. Molar mass calculations should not be combined with conversion problems. All volumes must be at standard temperature and pressure (STP). A balanced equation and molar masses should be included in the item. Calculations may include grams/moles/volume of reactant to grams/moles/volume of product.

HS-PSC-3 – Energy

HS-PSC-3.1 Students who demonstrate understanding can:
Ask questions to clarify the idea that electromagnetic radiation can be described either by a wave model or a particle model.

Supporting Content PS4.B: Electromagnetic Radiation

- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PSC-3.1)

Further Explanation: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include interference, diffraction, and photoelectric effect.

Assessment Limit: Assessment does not include using quantum theory.

HS-PSC-3.2 Students who demonstrate understanding can:
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.

Supporting Content PS3.A: Definitions of Energy

- 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. (HS-PSC-3.2, HS-PSC-3.3)

Supporting Content PS3.B: Conservation of Energy and Energy Transfer

- 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. (HS-PSC-3.2)
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PSC-3.2, HS-PSC-3.5)
- 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. (HS-PSC-3.2)
- The availability of energy limits what can occur in any system. (HS-PSC-3.2)

Further Explanation: Emphasis is on explaining the meaning of mathematical expressions used in the model.

Assessment Limit: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields. Two temperatures (initial and final), a temperature-time graph, or an enthalpy diagram must be provided.

HS-PSC-3.3 Students who demonstrate understanding can:
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).

Supporting Content PS3.A: Definitions of Energy

- 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. (HS-PSC-3.2, HS-PSC-3.3)
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PSC-3.3, HS-PSC-3.4)
- 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. (HS-PSC-3.3)

Further Explanation: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.

HS-PSC-3.4* Students who demonstrate understanding can:
Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. ---OPTIONAL

Supporting Content PS3.A: Definitions of Energy

- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PSC-3.3, HS-PSC-3.4)

Supporting Content PS3.D: Energy in Chemical Processes

- Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surroundings. (HS-PSC-3.4, HS-PSC-3.5)

Further Explanation: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include calorimeters, heat and cold packs, solar cells, solar ovens, and electrochemical cells. Examples of constraints could include use of renewable energy forms and efficiency.

Assessment Limit: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.

HS-PSC-3.5 Students who demonstrate understanding can:
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).

Supporting Content PS3.B: Conservation of Energy and Energy Transfer

- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PSC-3.2, HS-PSC-3.5)
- Uncontrolled systems always evolve toward more stable states—that is, toward a more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PSC-3.5)

Supporting Content PS3.D: Energy in Chemical Processes

- Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surroundings. (HS-PSC-3.4, HS-PSC-3.5)

Further Explanation: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually (endothermic/exothermic). Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.

Assessment Limit: For items involving specific heat, provide the equation $Q = mC_p\Delta T$ and specific heats. Include the melting and boiling points of water. Limit calculations to changes that do not involve a change of state. Perform gram to mole and mole to ΔH calculations. Use joules as a unit of measure, as opposed to calories.

Physical Science – Physics

HS-PSP-1 – Motion and Stability: Forces and Interactions

HS-PSP-1.1 Students who demonstrate understanding can:
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.

Supporting Content PS2.A: Forces and Motion

- Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PSP-1.1)

Further Explanation: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.

Assessment Limit: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.

HS-PSP-1.2 Students who demonstrate understanding can:
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.

Supporting Content PS2.A: Forces and Motion

- Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (HS-PSP-1.2)
- If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PSP-1.2, HS-PSP-1.3)

Further Explanation: Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle (Newton's first law).

Assessment Limit: Assessment is limited to systems of two macroscopic bodies moving in one dimension.

HS-PSP-1.3 Students who demonstrate understanding can:
Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

Supporting Content PS2.A: Forces and Motion

- If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PSP-1.2, HS-PSP-1.3)

Supporting Content ETS1.A: Defining and Delimiting an Engineering Problem

- 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. (HS-PSP-1.3)

Supporting Content ETS1.C: Optimizing the Design Solution

- 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. (HS-PSP-1.3)

Further Explanation: Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.

Assessment Limit: Assessment is limited to qualitative evaluations and/or algebraic manipulations.

HS-PSP-1.4 Students who demonstrate understanding can:
Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

Supporting Content PS2.B: Types of Interactions

- Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PSP-1.4)
- 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. (HS-PSP-1.4, HS-PSP-1.5)

Further Explanation: Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields.

Assessment Limit: Assessment is limited to systems with two objects. Base equations will be provided.

HS-PSP-1.5 Students who demonstrate understanding can:
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.

Supporting Content PS2.B: Types of Interactions

- 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. (HS-PSP-1.4, HS-PSP-1.5)

Supporting Content PS3.A: Definitions of Energy

- "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. (HS-PSP-1.5)

Assessment Limit: Assessment is limited to designing and conducting investigations with provided materials and tools.

HS-PSP-1.6 Students who demonstrate understanding can:
Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Supporting Content PS1.A: Structure and Properties of Matter

- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PSP-1.6)

Supporting Content PS2.B: Types of Interactions

- 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. (HS-PSP-1.6, *HS-PSC-1.3, HS-PSC-1.5*)

Further Explanation: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.

Assessment Limit: Assessment is limited to provided molecular structures of specific designed materials.

HS-PSP-2 – Energy

HS-PSP-2.1 Students who demonstrate understanding can:
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.

Supporting Content PS3.A: Definitions of Energy

- 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. (HS-PSP-2.1, HS-PSP-2.2)

Supporting Content PS3.B: Conservation of Energy and Energy Transfer

- 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. (HS-PSP-2.1)
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PSP-2.1, HS-PSP-2.4)
- 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. (HS-PSP-2.1)
- The availability of energy limits what can occur in any system. (HS-PSP-2.1)

Further Explanation: Emphasis is on explaining the meaning of mathematical expressions used in the model.

Assessment Limit: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.

HS-PSP-2.2 Students who demonstrate understanding can:
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).

Supporting Content PS3.A: Definitions of Energy

- 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. (HS-PSP-2.1, HS-PSP-2.2)
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PSP-2.2, HS-PSP-2.3)
- 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. (HS-PSP-2.2)

Further Explanation: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.

HS-PSP-2.3 Students who demonstrate understanding can:
Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Supporting Content PS3.A: Definitions of Energy

- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PSP-2.2, HS-PSP-2.3)

Supporting Content PS3.D: Energy in Chemical Processes

- Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PSP-2.3, HS-PSP-2.4)

Supporting Content ETS1.A: Defining and Delimiting an Engineering Problem

- 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. (HS-PSP-2.3)

Further Explanation: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of multiple energy forms and evaluations of efficiency.

Assessment Limit: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to examples of devices provided to students.

HS-PSP-2.4 Students who demonstrate understanding can:
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).

Supporting Content PS3.B: Conservation of Energy and Energy Transfer

- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PSP-2.1, HS-PSP-2.4)
- Uncontrolled systems always evolve toward more stable states—that is, toward a more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PSP-2.4)

Supporting Content PS3.D: Energy in Chemical Processes

- Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PSP-2.3, HS-PSP-2.4)

Further Explanation: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.

Assessment Limit: Assessment is limited to examples of closed system investigations.

HS-PSP-2.5 Students who demonstrate understanding can:
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.

Supporting Content PS3.C: Relationship Between Energy and Forces

- When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PSP-2.5)

Further Explanation: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.

Assessment Limit: Assessment is limited to systems containing two objects.

HS-PSP-3 – Waves

HS-PSP-3.1 Students who demonstrate understanding can:
Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

Supporting Content PS4.A: Wave Properties

- The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PSP-3.1)

Further Explanation: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.

Assessment Limit: Assessment is limited to algebraic relationships and describing those relationships qualitatively.

HS-PSP-3.2 Students who demonstrate understanding can:
Evaluate questions about the advantages of using digital transmission and storage of information.

Supporting Content PS4.A: Wave Properties

- Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PSP-3.2, HS-PSP-3.5)

Further Explanation: Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.

HS-PSP-3.3 Students who demonstrate understanding can:
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.

Supporting Content PS4.A: Wave Properties

- Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-PSP-3.3)

Supporting Content PS4.B: Electromagnetic Radiation

- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PSP-3.3)

Further Explanation: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.

Assessment Limit: Assessment does not include using quantum theory.

HS-PSP-3.4 Students who demonstrate understanding can:
Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

Supporting Content PS4.B: Electromagnetic Radiation

- When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. (HS-PSP-3.4)

Further Explanation: Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.

Assessment Limit: Assessment is limited to qualitative descriptions.

HS-PSP-3.5 Students who demonstrate understanding can:
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.

Supporting Content PS3.D: Energy in Chemical Processes

- Solar cells are human-made devices that likewise capture the Sun's energy and produce electrical energy. (HS-PSP-3.5)

Supporting Content PS4.A: Wave Properties

- Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PSP-3.2, HS-PSP-3.5)

Supporting Content PS4.B: Electromagnetic Radiation

- Photoelectric materials emit electrons when they absorb light of a high enough frequency. (HS-PSP-3.5)

Supporting Content PS4.C: Information Technologies and Instrumentation

- Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PSP-3.5)

Further Explanation: Examples could include solar cells capturing light and converting it to electricity, medical imaging, and communications technology.

Assessment Limit: Assessments are limited to qualitative information. Assessments do not include band theory.

Earth and Space Science

HS-ESS-1 – Earth's Place in the Universe

HS-ESS-1.1 Students who demonstrate understanding can:
Develop a model based on evidence to illustrate the life span of the Sun and the role of nuclear fusion in the Sun's core to release energy that eventually reaches Earth in the form of radiation.

Supporting Content ESS1.A: The Universe and Its Stars

- The star called the Sun is changing and will burn out over a lifespan of approximately 10 billion years. (HS-ESS-1.1)

Supporting Content PS3.D: Energy in Chemical Processes and Everyday Life

- Nuclear fusion processes in the center of the Sun release the energy that ultimately reaches Earth as radiation. (HS-ESS-1.1)

Further Explanation: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the Sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the Sun's radiation varies due to sudden solar flares ("space weather"), the 11-year sunspot cycle, and non-cyclic variations over centuries.

Assessment Limit: Assessment does not include details of the atomic and subatomic processes involved with the Sun's nuclear fusion.

HS-ESS-1.2 Students who demonstrate understanding can:
Construct an explanation of the current model of the origin of the universe based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.

Supporting Content ESS1.A: The Universe and Its Stars

- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS-1.2, HS-ESS-1.3)
- Origin theories are supported by evidence such as observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. Other than the hydrogen and helium formed at the time of the event, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS-1.2, HS-ESS-1.3)

Supporting Content PS4.B: Electromagnetic Radiation

- 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. (HS-ESS-1.2)

Further Explanation: Emphasis is on the astronomical evidence of the redshift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the event, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases (from the spectra of electromagnetic radiation from stars), which matches that predicted by the scientific model (3/4 hydrogen and 1/4 helium).

HS-ESS-1.3 Students who demonstrate understanding can:
Communicate scientific ideas about the way stars, over their life cycle, transform elements.

Supporting Content ESS1.A: The Universe and Its Stars

- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS-1.2, HS-ESS-1.3)
- Origin theories are supported by evidence such as observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. Other than the hydrogen and helium formed at the time of the event, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS-1.2, HS-ESS-1.3)

Further Explanation: Emphasis is on the way nucleosynthesis, and therefore the different elements created, varies as a function of the mass of a star and the stage of its lifetime.

Assessment Limit: Details of the many different nucleosynthesis pathways for stars of different masses are not assessed.

HS-ESS-1.4 Students who demonstrate understanding can:
Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

Supporting Content ESS1.B: Earth and the Solar System

- 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. (HS-ESS-1.4)

Further Explanation: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons.

Assessment Limit: Mathematical representations for the gravitational attraction of bodies and Kepler's Laws of orbital motions should not deal with more than two bodies, nor involve calculus.

HS-ESS-1.5 Students who demonstrate understanding can:
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.

Supporting Content ESS1.C: The History of Planet Earth

- Continental rocks are generally much older than the rocks of the ocean floor. (HS-ESS-1.5)

Supporting Content ESS2.B: Plate Tectonics and Large-Scale System Interactions

- 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. (HS-ESS-1.5)

Supporting Content PS1.C: Nuclear Processes

- Spontaneous radioactive decay follows a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (HS-ESS-1.5, HS-ESS-1.6)

Further Explanation: Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages of oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust decreasing with distance away from a central ancient core (a result of past plate interactions).

HS-ESS-1.6 Students who demonstrate understanding can:
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.

Supporting Content ESS1.C: The History of Planet Earth

- Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. (HS-ESS-1.6)

Supporting Content PS1.C: Nuclear Processes

- Spontaneous radioactive decay follows a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (HS-ESS-1.5, HS-ESS-1.6)

Further Explanation: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, Moon rocks, and Earth's oldest minerals); the sizes and compositions of solar system objects; and the impact cratering record of planetary surfaces.

HS-ESS-2 – Earth's Systems

HS-ESS-2.1 Students who demonstrate understanding can:
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.

Supporting Content ESS2.A: Earth Materials and Systems

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS-2.1, HS-ESS-2.2)

Supporting Content ESS2.B: Plate Tectonics and Large-Scale System Interactions

- Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. (HS-ESS-2.1)

Further Explanation: Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, mass wasting, and coastal erosion).

Assessment Limit: Assessment does not include memorization of the details of the formation of specific geographic features of Earth's surface.

HS-ESS-2.2 Students who demonstrate understanding can:
Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

Supporting Content ESS2.A: Earth Materials and Systems

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS-2.1, HS-ESS-2.2)

Supporting Content ESS2.D: Weather and Climate

- 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. (HS-ESS-2.2, HS-ESS-2.4)

Further Explanation: Examples of system interactions include how melting ice exposes darker land, which increases temperatures and causes more ice to melt; how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.

HS-ESS-2.3 Students who demonstrate understanding can:
Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

Supporting Content ESS2.A: Earth Material and Systems

- 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, 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. (HS-ESS-2.3)

Supporting Content ESS2.B: Plate Tectonics and Large-Scale System Interactions

- 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. (HS-ESS-2.3)

Supporting Content PS4.A: Wave Properties

- Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet. (HS-ESS-2.3)

Further Explanation: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth's three-dimensional structure obtained from seismic waves, records of the rate of change of Earth's magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth's layers from high-pressure laboratory experiments.

HS-ESS-2.4 Students who demonstrate understanding can:
Use a model to describe how variations in the flow of energy into and out of Earth's systems result in variations in climate.

Supporting Content ESS1.B: Earth and the Solar System

- 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 variations. (HS-ESS-2.4)

Supporting Content ESS2.A: Earth Material and Systems

- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the Sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (e.g., ice ages) to very long-term tectonic cycles. (HS-ESS-2.4)

Supporting Content ESS2.D: Weather and Climate

- 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. (HS-ESS-2.2, HS-ESS-2.4)
- Changes in carbon dioxide concentrations in the atmosphere affect climate. (HS-ESS-2.6, HS-ESS-2.4)

Further Explanation: Examples of the causes of variations in climate differ by timescale: over 1–10 years: large volcanic eruption, ocean circulation; 10–100s of years: changes in human activity, ocean circulation, solar output; 10–100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10–100s of millions of years: long-term changes in atmospheric composition.

Assessment Limit: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.

HS-ESS-2.5 Students who demonstrate understanding can:
Plan and conduct an investigation of how the chemical and physical properties of water contribute to the mechanical and chemical mechanisms that affect Earth materials and surface processes.

Supporting Content ESS2.C: The Roles of Water in Earth's Surface Processes

- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy; transmit sunlight; expand upon freezing; dissolve and transport materials; and lower the viscosities and melting points of rocks. (HS-ESS-2.5)

Further Explanation: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).

HS-ESS-2.6 Students who demonstrate understanding can:
Develop a model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

Supporting Content ESS2.D: Weather and Climate

- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS-2.6, HS-ESS-2.7)
- Changes in carbon dioxide concentrations in the atmosphere affect climate. (HS-ESS-2.4, HS-ESS-2.6)

Further Explanation: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.

HS-ESS-2.7 Students who demonstrate understanding can:
Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

Supporting Content ESS2.D: Weather and Climate

- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS-2.6, HS-ESS-2.7)

Supporting Content ESS2.E: Biogeology

- 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. (ESS2-HS-7)

Further Explanation: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.

Assessment Limit: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.

HS-ESS-3 – Earth and Human Activity

HS-ESS-3.1 Students who demonstrate understanding can:
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.

Supporting Content ESS3.A: Natural Resources

- Resource availability has guided the development of human society. (HS-ESS-3.1, *HS-LS-2.6*)

Supporting Content ESS3.B: Natural Hazards

- Natural hazards and other geologic events have shaped the course of human history. They have altered the sizes of human populations and have driven human migrations. (HS-ESS-3.1)

Further Explanation: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting, and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.

HS-ESS-3.2 Students who demonstrate understanding can:
Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

Supporting Content ESS3.A: Natural Resources

- All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical benefits, costs and risks. New technologies and social regulations can change the balance of these factors. (HS-ESS-3.2)

Supporting Content ETS1.B: Developing Possible Solutions

- 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 factors. (HS-ESS-3.2, HS-ESS-3.4)

Further Explanation: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) and on minimizing impacts. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas).

HS-ESS-3.3 Students who demonstrate understanding can:
Illustrate relationships among management of natural resources, the sustainability of human populations, and biodiversity.

Supporting Content ESS3.C: Human Influences on Earth Systems

- The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS-3.3)

Further Explanation: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.

HS-ESS-3.4 Students who demonstrate understanding can:
Evaluate or refine a scientific or technological solution that mitigates or enhances human influences on natural systems.

Supporting Content ESS3.C: Human Influences on Earth Systems

- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS-3.4)

Supporting Content ETS1.B: Developing Possible Solutions

- 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 factors. (HS-ESS-3.2, HS-ESS-3.4)

Further Explanation: Examples of data on the influences of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples of human contributions could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as cloud seeding).

HS-ESS-3.5 Students who demonstrate understanding can:
Analyze geoscience data and the results from global climate models to make an evidence-based explanation of how climate variability can affect Earth's systems on a global and regional scale.

Supporting Content ESS3.C: Human Influences on Earth Systems

- Human abilities to model, predict, and manage current and future effects on Earth's systems are improving with advancing technologies. (HS-ESS-3.5)

Further Explanation: Examples of evidence, for both data and climate model outputs, are for climate variations (such as precipitation and temperature) and their associated effects (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).

Assessment Limit: Assessment is limited to one example of a climate variation and its associated effect.

HS-ESS-3.6 Students who demonstrate understanding can:
Communicate how relationships among Earth systems are being influenced by human activity.

Supporting Content ESS2.D: Weather and Climate

- Current models project that average global temperatures will continue to rise. The outcomes projected by these models depend on the amounts of greenhouse gases added to the atmosphere each year and the ways these gases are stored by Earth's systems. (HS-ESS-3.6)

Supporting Content ESS3.C: Human Influences on Earth Systems

- Through computer simulations and scientific research, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are influenced by human activities. (HS-ESS-3.6)

Further Explanation: Examples of Earth systems are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.

Assessment Limit: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.