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# Aligning science assessment standards: Louisiana and the 2009 National Assessment of Educational Progress (NAEP)

**July 2007**

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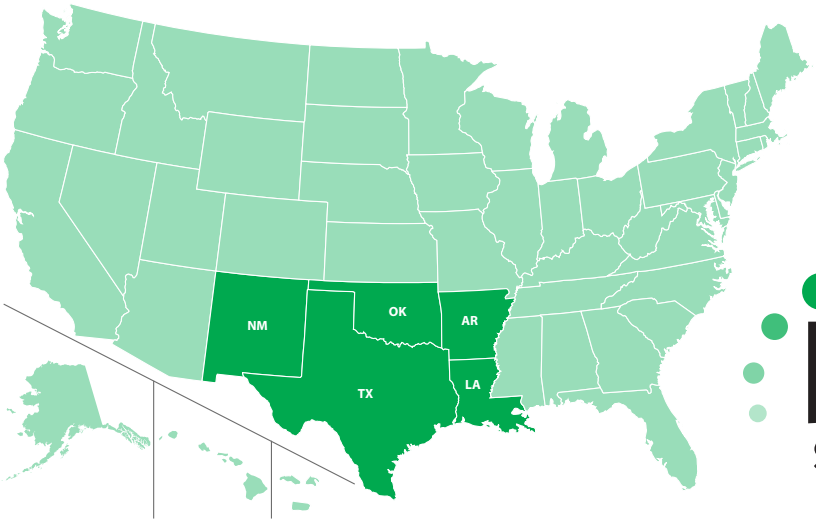


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This report is available on the regional educational laboratory web site at http://ies.ed.gov/ncee/edlabs.

*Summary*

# Aligning science assessment standards: Louisiana and the 2009 National Assessment of Educational Progress (NAEP)

**This policy research document is intended for Louisiana policymakers to use when examining possible changes to the state assessment's alignment with the National Assessment of Educational Progress (NAEP). The 2009 NAEP test is not yet in existence, so the purpose of this report is to give policymakers a headstart in determining where they might, if they so decide, begin to make changes in their assessment standards and specifications to develop an assessment system more closely aligned to that used for the NAEP.**

Reviewers observed that NAEP standards are based on descriptions of phenomena, whereas Louisiana's standards are based on explanations of what a student does to explore the phenomena. They also found that NAEP standards tend to be widely inclusive (including, for example, heat and electrical conductivity in the same standard) whereas most states tend to see such topics as part of two separate standards or benchmarks. Reviewers found Louisiana's science standards to be rigorous and found consistent spiraling through the grade levels. However, they also noted that teachers might more easily discern nuances in the standards if the grade level expectations, as well as the "key concepts" within the assessment guides, were integrated with the benchmarks.

In comparing Louisiana benchmarks and grade level expectations with the NAEP, the overall alignment ratings for elementary, middle, and high school are generally very high. The overall alignment rating for Louisiana science content and NAEP grade 4 is 2.6. (A rating of 1 indicates no alignment and a rating of 3, full alignment.) For grade 8, the alignment rating is 2.1. For grade 12, the rating is 2.5. Louisiana middle school content is partially aligned with the NAEP grade 8, while grade 4 and high school are most often fully aligned.

The instances of partial alignment at all grade levels are due primarily to the fact that Louisiana's standards often imply NAEP content and the NAEP is often more detailed in its presentation of content. In addition, Louisiana contains many benchmarks that are unaddressed by the NAEP content statements. Generally, the combination of Louisiana's benchmarks and grade level expectations at all grade levels aligns very well with the NAEP content statements, because the grade level expectations often parallel NAEP statements in their level of detail.

This report reveals current alignment issues between the state's tests and the future NAEP tests and may be especially important to policymakers considering revising

science standards and assessments in line with No Child Left Behind requirements for state science tests in elementary, middle, and high schools. If state policymakers wish to increase the alignment between the state assessments and the NAEP, an area to consider is developing the comprehensive science task into a hands-on performance task. Revising assessments requires considerable time and resources, so policymakers must carefully consider their capacity to make changes and the degree to which such changes will benefit students.

### Grade 4 alignment

All grade 4 NAEP content statements are at least partially addressed by Louisiana benchmarks and grade level expectations. The Louisiana benchmarks also contain many items that are not listed in the NAEP's content statements. The combination of Louisiana's benchmarks and grade level expectations aligned very well with the NAEP content statements. Many partially aligned content items were found to be so because they imply content explicitly stated by the NAEP.

Reviewers observed that NAEP standards are based on descriptions of phenomena, whereas Louisiana's standards are based on explanations of what a student does to explore the phenomena. They also found that NAEP standards tend to be widely inclusive (including, for example, heat and electrical conductivity in the same standard) whereas most states tend to see such topics as part of two separate standards or benchmarks. Reviewers found Louisiana's science standards to be rigorous and found consistent spiraling through the grade levels. However, they also noted that teachers might more easily discern nuances in the standards if the grade level expectations, as well as the "key concepts" within the assessment guides, were integrated with the benchmarks.

The majority of NAEP content statements are fully addressed by various combinations of Louisiana benchmarks and grade level expectations, and the overall alignment rating for Louisiana and NAEP science content at grade 4 is 2.6.

### Grade 8 alignment

The Louisiana benchmarks cover many content topics not assessed by the NAEP, while most of the Louisiana content in its benchmarks and grade level expectations only partially addresses the NAEP content statements. This is primarily because Louisiana's standards often imply NAEP content and because the NAEP is often more detailed in its presentation of content. The overall alignment rating for Louisiana and the NAEP grade 8 is 2.1, indicating partial alignment.

### Grade 12 alignment

The Louisiana benchmarks contain many items not assessed by the NAEP. Several Louisiana benchmarks were noted for alignment to distinct parts of a more detailed NAEP content statement. Overall, Louisiana is well aligned to the NAEP. Many of the Louisiana high school standards only partially address the NAEP content statements at grade 12, because Louisiana's benchmarks often imply NAEP content and because the NAEP is often more detailed in its presentation of content. The overall alignment rating is 2.5.

## Test specifications

The Louisiana assessment guides, which define the specifications for the state tests, ensure that testing of student knowledge and skills does not rely solely on multiple-choice items by including short constructed-response items and a comprehensive science task at each grade level. That enables a wider range of knowledge types to be tested than can be tested with multiple-choice alone. Louisiana records its proportions differently than the NAEP, so it is difficult to directly compare the relative amounts of testing time devoted to different topics. However, when focusing just on the three topic areas tested by the NAEP, the proportions of NAEP testing times are the same as the proportions of points in the Louisiana test at grade 4 and in high school, and they are similar at grade 8, where Louisiana's points are allocated equally across subjects while NAEP students are tested slightly more on Earth and space science. Overall, there is a match between the test specifications in Louisiana's assessment guides and the NAEP science assessment and item specifications.

Standards and test specifications represent the starting point for the development of tests and test items. In the ideal alignment study state science assessments would be compared with NAEP assessments directly at the item level. At some future date the NAEP 2009 assessment items may be available for such a study.

**July 2007**

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## Tables

**This policy research document is intended for policymakers to use when examining possible changes to the state assessment's alignment with the National Assessment of Educational Progress (NAEP).**

## BACKGROUND TO THE STUDY

This report presents the findings of an alignment study comparing the new science framework for the 2009 NAEP and the accompanying science assessment and item specifications with the Louisiana state science assessment. More details about the documents compared are in appendix A. The study was conducted for the Regional Education Laboratory Southwest, funded by the Institute of Education Sciences, to provide research and support to Arkansas, Louisiana, New Mexico, Oklahoma, and Texas. The study was undertaken in anticipation of a growing need in the region to be better informed about how state assessment standards in science compare with those tested in the NAEP.

The 2009 NAEP test is not yet in existence, so the purpose of this report is to give policymakers a headstart in determining where they might, if they so decide, begin to make changes in their assessment standards and specifications to develop an assessment system more closely aligned with that used for the NAEP.

Five factors make this study timely. First, the importance of state science assessments has been increased by the No Child Left Behind Act of 2001. Beginning in the 2007/08 school year, states are required to administer science assessments to all students in each of the elementary, middle, and high school levels, holding states and local school districts accountable for student academic achievement in science (NCLB, 2001).

Second, the NAEP is increasingly being used as a benchmark against which student achievement across the nation can be compared (Linn, 2005; Linn, Baker, & Herman, 2005). The NAEP has been dubbed the "nation's report card," and when fresh NAEP results are released—as they were for science in 2006, following an administration of the test in 2005—the media report the results (Cavanagh, 2006a, 2006b). Although states are not sanctioned for failing to demonstrate NAEP student performance improvement, NAEP data do provide an external accountability benchmark and serve to verify student achievement on state assessments. In fact, the National Center for Education Statistics has a website (http://nces.ed.gov/nationsreportcard/nde/statecomp/) that allows anyone to create customized comparative reports based on the latest NAEP data. So anyone can create tables that compare states and jurisdictions based on the average scale scores for selected groups of public school students within a single assessment year, or compare the change in performance between two assessment years.

Third, NAEP data are being used more in education research to investigate how the No Child Left

Behind Act provisions have played out in different states. For example, Olson (2005) compared the percentages of students at or above the proficient level on the 2005 state grade 8 mathematics assessments in 33 states. The study showed that, on average, 33 percent more students scored at or above the proficient level according to the state assessments than did so according to the NAEP. As yet, no similar study has been done of science, but with the release of the 2005 NAEP results it is now possible to do so.

Fourth, political attention is beginning to focus on using the NAEP as a yardstick for measuring state standards (Olson, 2007). In January 2007 two bills were introduced in Congress, one seeking to encourage states to benchmark their own standards and tests to the NAEP and the other calling for states to adopt voluntary "American education content standards" in mathematics and science that would be developed by the National Assessment Governing Board, the body responsible for the NAEP. These issues will doubtless be topics of debate in the upcoming reauthorization of the No Child Left Behind Act.

Fifth, the standards and test specifications that form the blueprint for the content the NAEP science assessment covers and the types of items it uses were revised in 2006. The 2009 NAEP framework takes account of the latest knowledge on science learning and assessment, which suggests that measuring student understanding involves much more than assessing factual knowledge. It defines the science knowledge and skills that science-literate students should possess at grades 4, 8, and 12. The assessment itself, while retaining some familiar paper-and-pencil assessment formats, will also include student performance assessments in both classroom settings and computer simulations. The 2009 NAEP framework will determine the shape of NAEP science assessments through 2017, setting the direction of science assessment across the nation.

**Several factors are working to raise the NAEP to a de facto national benchmark, and states want to know how well their state standards align with it**

These factors are working together to gradually raise the NAEP to a de facto national benchmark, and states naturally want to know how well their state standards align with the NAEP so they can make informed decisions about possible changes to their own standards and assessment systems. This report describes the results of a systematic alignment study of science assessment standards conducted for that purpose. Details of the study are in appendix B.

The intent of this report is to inform those in the Louisiana Department of Education responsible for shaping the state assessment in science how the current assessment standards and test specifications compare with those of the NAEP 2009 assessment.

Similar reports have been completed for Arkansas, New Mexico, Oklahoma, and Texas, but there is no intent to compare Louisiana with these states. This report shows where there is good content alignment with NAEP standards, identifies where there is partial alignment, pinpoints NAEP standards where there are no corresponding state standards, and highlights where the Louisiana standards go beyond the NAEP. It also deals with the assessment specifications, showing what percentages of the NAEP assessment at each grade level are devoted to different science topics and comparing that to the coverage of the topics in the Louisiana assessment. And it compares the proportions of types of items used to test students' science knowledge and skills. Through comprehensive comparative analysis, the report provides a way for the Louisiana Department of Education to gauge how well its tests are doing in covering the depth of science understanding expected on the NAEP.

The NAEP science standards were compared with the Louisiana elementary level benchmarks and the Louisiana grade level expectations. Louisiana recommended the use of its grade level expectations for this study, as the state's assessment specialists indicated that assessment content was drawn not only from the benchmarks, but also from the grade level expectations. Thus, while the

alignment studies performed for other states in the Southwest Region were completed using only the curriculum content or grade level expectations in the assessment frameworks, Louisiana's alignment was performed using the complete set of its benchmarks and grade level expectations.

The results are presented in the summary tables and narratives in the sections that follow. Those sections provide an analysis that highlights the differences found between NAEP's content and Louisiana's content as presented by the Louisiana Educational Assessment Program assessment guides (grades 4, 8, and 11) and the Louisiana grade level expectations. For more detail about the alignment of the state content to the individual content statements of the NAEP, turn to the tables in appendixes C–E. They show exactly which Louisiana standards align with a particular NAEP statement and, in cases of partial alignment, explain why the alignment is incomplete. For a discussion of methodology, see box 1 and appendix B.

## CONTENT ALIGNMENT AT GRADE 4

For grade 4, the NAEP provides 33 distinct content statements (displayed in parentheses in table 1). Twenty-one of these content statements (64 percent) are fully addressed by Louisiana content in the benchmarks and grade level expectations, and 12 (36 percent) are partially addressed. No NAEP content statements are unaddressed.

The average alignment rating for grade 4 is 2.6 (table 1). The majority of content statements were

BOX 1

### Methodology

The chief research questions driving this study were: "To what extent do current state assessment standards cover the content on which NAEP 2009 assessments will be based?" and "To what extent do current state assessment specifications align with the NAEP 2009 assessment specifications?"

The methodology used to answer these questions followed the successful pattern of a similar study conducted by WestEd in New England, which examined the alignment of math and reading standards with the NAEP. The methodology developed by WestEd for the New England study was designed to include all the most prominent alignment methodologies, which are discussed in appendix B. Thus far, alignment studies and methods have focused on aligning standards with tests, whereas the objective of this study was to compare one set of assessment standards and specifications with another. The methodology in this study, however, is based on methods for aligning standards with tests, because similar principles are used in both types of alignments.

In this study reviewers followed the methodology of the portion of the previous study examining alignment between two sets of standards. Test blueprints were examined to find correspondence between the two documents. Reviewers performed gap analyses to identify content included in one set of standards but not the other, identified issues of order so they could reveal differences in the grade levels at which standards appear, and examined the degree to which the standards and assessments cover content to the same depth and have similar cognitive demands (depth-of-knowledge consistency) and the degree to which assessments cover the same range of content as the corresponding standards (range-of-knowledge correspondence) to determine whether there is a match between the state and the NAEP in the level of detail, cognitive demands, and range of content covered. A coding scheme was used to indicate alignment issues and reviewer ratings, and a matrix-like format was created to facilitate alignment.

Reviewers attended several training sessions, conducted individual reviews, and then met in teams of two to reach consensus on ratings. This consensus method was designed to create one consensus rating per NAEP standard with the help of a moderator and was not intended to allow for disagreements. This methodology was determined to be best suited to the scope and timing of this study. The consensus methodology is designed to highlight areas for states to examine, not to gather large amounts of data, record multiple ratings, or measure interrater reliability.

TABLE 1

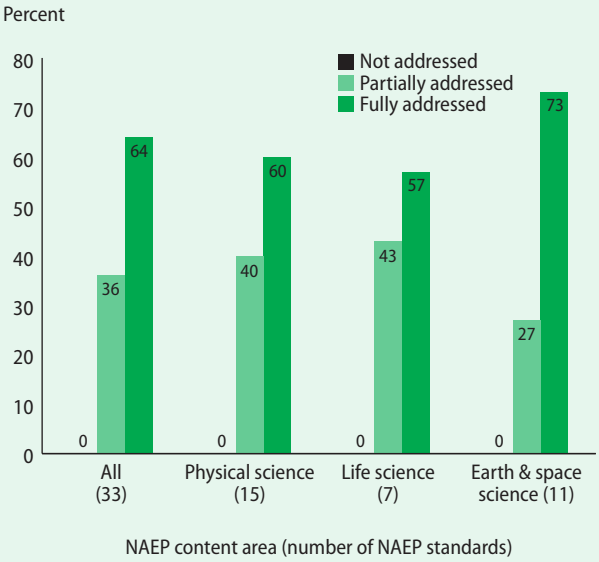
**Average ratings of alignment of Louisiana grade 5 benchmarks and grade level expectations and National Assessment of Educational Progress grade 4 science content statements**

| NAEP content area (number of NAEP standards) | Average rating |
|---|---|
| Overall physical science (15) | 2.6 |
| Matter (6) | 2.7 |
| Energy (5) | 2.4 |
| Motion (4) | 2.8 |
| Overall life science (7) | 2.6 |
| Structures and functions of living systems (4) | 2.5 |
| Changes in living systems (3) | 2.7 |
| Overall Earth and space science (11) | 2.7 |
| Earth and space in time (3) | 3.0 |
| Earth structures (3) | 2.3 |
| Earth systems (5) | 2.8 |
| All content (33) | 2.6 |

*Note:* Rating is based on a scale of 1 to 3, where 1 indicates that state standards do not address the NAEP content statement, 2 that they partially address the NAEP content statement, and 3 that they fully address or exceed the NAEP content statement by the targeted grade level.

FIGURE 1

**The majority of Louisiana elementary school standards fully address National Assessment of Educational Progress content statements**




given ratings of 3, which means that state standards most often fully address the NAEP content statements (figure 1 and appendix C).

Reviewers observed that NAEP standards are based on descriptions of phenomena, whereas Louisiana's standards are based on explanations of what a student does to explore the phenomena. In addition, reviewers found that NAEP standards tend to be widely inclusive (including, for example heat and electrical conductivity in the same standard) whereas most states tend to see such topics as part of two separate standards or benchmarks.

## Areas of full alignment

Twenty-one NAEP grade 4 content statements are fully addressed by Louisiana benchmarks and grade level expectations. Nine of 15 physical science NAEP statements have full alignment with Louisiana, as do 4 of 7 life science statements and 8 of 11 Earth and space science statements.

Reviewers found Louisiana's science standards to be rigorous and found consistent spiraling through the grade levels.

The 21 NAEP grade 4 content statements fully addressed by Louisiana are P4.1—measurable properties of objects and substances, P4.2—absorption, reflection, and conduction, P4.3—states of matter, P4.6—heating and cooling, P4.7—forms of energy (heat, electricity, light, sound), P4.10—vibrations and sound, P4.13—objects in motion; speed, P4.14 and P4.15—forces affecting motion, L4.3 and L4.4—interdependence of organisms, L4.5 and L4.6—heredity and reproduction, E4.1 and E4.2—objects in the universe and patterns in the sky, E4.3—history of Earth and Earth's surface changes, E4.4—natural Earth materials, E4.7—role of the sun in Earth systems, E4.8 and E4.9—climate and weather, and E4.11—humans depend on and change their environments.

## Areas of partial alignment

Thirty-six percent of the NAEP grade 4 content statements have partial alignment, in large part because many Louisiana standards imply content

explicitly stated by the NAEP and because NAEP content statements are often more detailed than Louisiana's.

Raters found that many Louisiana benchmarks imply content that the NAEP addresses in depth. For example, Louisiana PS-E-A5 and GLE PS 4.25 mention creating and separating mixtures, while NAEP's P4.4 covers content regarding objects being composed of single or multiple substances. The Louisiana standards likely imply the content regarding pure substances, but they do not explicitly state the single-substance composition of an object. In life science, the NAEP's L4.2 lists air, water, a source of energy, and light as needs for organisms, while LS-E-A1 and other corresponding grade level expectations do not specifically list such needs. Additionally, in Earth and space science, E4.10 lists fuels, metals, fresh water, and farmland as limited Earth resources, while Louisiana's matching benchmark and grade level expectations mention "resources" but do not specify those that the NAEP lists.

Reviewers also noted that teachers might more easily discern nuances in the standards if the grade level expectations, as well as the "key concepts" within the assessment guides, were integrated with the benchmarks.

The partially aligned NAEP standards are P4.4—composition of objects, P4.5—magnets, P4.8—heat, conductors, and increasing temperature, P4.9—light travel, P4.11—electrical circuits, P4.12—an object's position, L4.1—basic needs of organisms, L4.2—basic needs of plants and animals, L4.7—characteristics enabling survival in different environments, E4.5—properties of natural materials that sustain plant and animal life, E4.6—Earth materials for human use, and E4.10—limited supply of Earth resources.

## Areas of nonalignment

There were no areas of nonalignment between NAEP grade 4 content statements and Louisiana grade 4 benchmarks.

## Areas where Louisiana benchmarks go beyond the NAEP content statements

Louisiana has 60 benchmarks for grade 4. The NAEP does not address the 13 science as inquiry benchmarks, 5 of the 13 life science benchmarks, or 4 of the 13 Earth and space science benchmarks.

The NAEP addresses all of Louisiana's physical science and science and the environment benchmarks. However, the NAEP often implies content that is addressed in Louisiana, and in some instances, Louisiana contains more detailed physical science content than the NAEP. In science and the environment, the NAEP minimally and vaguely addresses all five Louisiana benchmarks.

The NAEP does not address the science as inquiry benchmarks because the NAEP discusses inquiry in a section separate from the content statements, called "science practices," intended to crosscut all NAEP content.

In life science, the NAEP does not address four of the six benchmarks in Louisiana's category of characteristics of organisms (LS-E-A2, A3, A5 and A6), which contains content regarding distinguishing between living and nonliving things; locating and comparing plant, animal, and human structures and functions; and recognizing the food groups necessary for maintaining a healthy body. The NAEP does not address three of the seven Earth and space science benchmarks, all in the category of properties of Earth materials (ESS-E-A5, A6 and A7), which contains content regarding the composition of rocks, variations in soil, and investigating fossils.

**The majority of NAEP content statements for grade 4 are fully addressed by the Louisiana benchmarks and grade level expectations for grade 4**

## Summary of grade 4 alignment

All NAEP content items are at least partially addressed by Louisiana benchmarks and grade level expectations. The Louisiana benchmarks also

contain many items not listed in the NAEP's content statements. The combination of Louisiana's benchmarks and grade level expectations aligned very well with the NAEP content statements. The partially aligned content items were so because Louisiana's benchmarks and grade level expectations often implied content explicitly stated by the NAEP.

Reviewers made the general observation that NAEP standards are based on descriptions of phenomena, whereas Louisiana's standards are based on explanations of what a student does to explore the phenomena. They also found that NAEP standards tend to be widely inclusive (including, for example heat and electrical conductivity in the same standard), whereas most states see such topics as part of two separate standards or benchmarks. Reviewers found Louisiana's science standards to be rigorous and found consistent spiraling through the grade levels. However, they also noted that teachers might more easily discern nuances in the standards if the grade level expectations, as well as the "key concepts" in the assessment guides, were integrated with the benchmarks.

The majority of NAEP content statements are fully addressed by the Louisiana benchmarks and grade level expectations, and the overall alignment rating for Louisiana and NAEP science content at grade 4 is 2.6.

## CONTENT ALIGNMENT AT GRADE 8

For grade 8, the NAEP provides 43 distinct content statements (displayed in parentheses in table 2). Seven (16 percent) of these content statements are fully addressed by Louisiana benchmarks, 33 (77 percent) are partially addressed, and three (7 percent) are unaddressed.

The average alignment rating for grade 8 is 2.1. The majority of content statements were given ratings of 2, which means that state standards partially address the NAEP content statements (figure 2 and appendix D).

TABLE 2

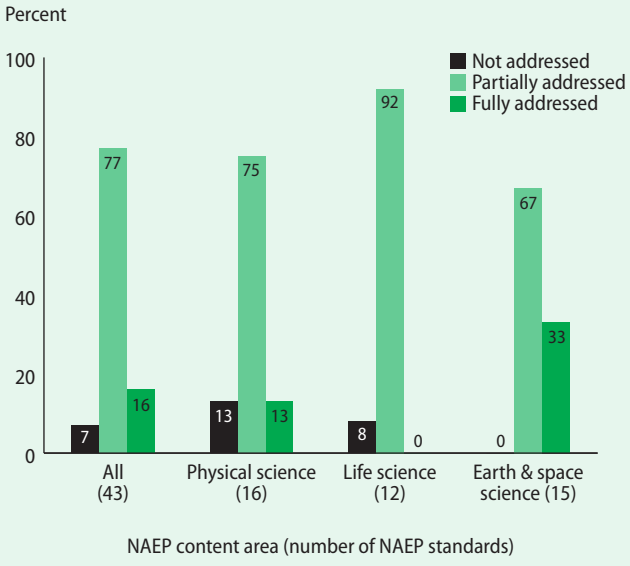
**Average ratings of alignment of Louisiana middle school science benchmarks and grade level expectations and National Assessment of Educational Progress grade 8 science content statements**

| NAEP content area (number of NAEP standards) | Average rating |
|---|---|
| Overall physical science (16) | 2.0 |
| Matter (7) | 2.0 |
| Energy (6) | 1.8 |
| Motion (3) | 2.3 |
| Overall life science (12) | 1.9 |
| Structures and functions of living systems (8) | 2.0 |
| Changes in living systems (4) | 1.8 |
| Overall Earth and space science (15) | 2.3 |
| Earth and space in time (4) | 2.5 |
| Earth structures (6) | 2.2 |
| Earth systems (5) | 2.4 |
| All content (43) | 2.1 |

*Note:* Rating is based on a scale of 1 to 3, where 1 indicates that state standards do not address the NAEP content statement, 2 that they partially address the NAEP content statement, and 3 that they fully address or exceed the NAEP content statement by the targeted grade level.

FIGURE 2

**The majority of Louisiana middle school standards partially address National Assessment of Educational Progress content statements**



## Areas of full alignment

The seven NAEP content statements with which Louisiana is fully aligned are P8.1—properties of solids, liquids, and gases and the particulate model of matter, P8.16—forces, including magnitude, direction and net force, E8.2—gravity and the solar system, E8.4—Earth processes and the measurement of geologic time, E8.8—Earth's layers, E8.12—causes of seasons, and E8.14—the water cycle. Five of the seven fully aligned content statements are in Earth and space science. Earth and space science is the section of Louisiana's standards most closely aligned with the NAEP's standards.

## Areas of partial alignment

None of the 12 life science content statements is fully addressed by Louisiana benchmarks and grade level expectations. The vast majority of NAEP life science standards were given partial alignment ratings with Louisiana content, largely because many NAEP content statements are more detailed than the benchmark statements.

Reviewers often found that Louisiana's standards do not address corresponding NAEP standards in the same amount of detail. For example, P8.5 deals with substances and their classifications according to physical and chemical properties. Louisiana's matching standards (PS-M-A3 and GLE 6.4) cover grouping substances according to similar properties and differentiating between physical and chemical properties of substances. However, the NAEP's standard also details classes of substances, such as metals and acids, while Louisiana does not provide such detailed examples. Another example is the alignment between the NAEP's L8.1 and GLEs 5.15, 5.16 and 7.2. The NAEP contains content about the cellular composition of organisms, as well as the composition and functioning of cells, while the matching grade level expectations contain more general content about identifying and observing components and structures of cells.

Raters found that Louisiana's benchmarks often imply content that the NAEP addresses in depth. For example, Louisiana's LS-M-B1 refers to mitosis and meiosis, which may imply content regarding differentiation of cells and the formation of embryos, addressed in NAEP L8.2. In addition, E8.13 states that oceans affect climate because water holds a large amount of heat, while the Louisiana benchmark ESS-M-A11 and GLEs 8.27 and 8.44 do not go into similar depth regarding the heat-retaining properties of water and the ocean's effect on weather.

## Areas of nonalignment

Three NAEP content items are unaddressed by Louisiana benchmarks, two in physical science and one in life science. The items are P8.2—chemical properties of substances being explained by the arrangement of atoms and molecules, P8.13—nuclear reactions in the sun and photosynthesis, and L8.10—characteristics of organisms influenced by heredity and environment.

**Most of the Louisiana benchmarks and grade level expectations for grade 8 only partially address the NAEP content statements for grade 8**

Louisiana's benchmarks often emphasize different areas than does the NAEP. For example, the content area of heredity and reproduction is found in both the NAEP's and Louisiana's life science sections; however, the standards focus on different topics. Louisiana discusses chromosomes, genes, and passing traits onto offspring, while the NAEP details sexual and asexual reproduction, the importance of reproduction for the survival of a species, and heredity versus the environment.

## Areas where Louisiana benchmarks go beyond the NAEP content statements

Forty-seven Louisiana benchmark statements are not covered by the NAEP. The NAEP does not address the 15 Louisiana benchmarks in science as inquiry, 7 of the 22 in physical science, 9 of

the 16 in life science, 9 of the 23 in Earth and space science, or 7 of the 10 in science and the environment.

The NAEP does not address the 15 science as inquiry benchmarks because it discusses inquiry in a section separate from the content statements, called "science practices," intended to crosscut all NAEP content.

In physical science, the NAEP does not address, for example, how factors such as temperature influence chemical reactions (PS-M-A8) or understanding that energy is involved in chemical reactions (PS-M-C7). In life science, the NAEP does not address human body systems and body changes (LS-M-A5 and A6) or investigating ecosystems (LS-M-C3). In Earth and space science, the NAEP does not address investigating characteristics of earthquakes and volcanoes (ESS-M-A3) or the causes and combating of coastal erosion (ESS-M-A8). The NAEP does not have a section devoted to science and the environment, so it does not address many of that section's benchmarks, including distinguishing between renewable and nonrenewable resources (SE-M-A6) and identifying types of soil erosion and preventive measures (SE-M-A10). Some of the nonalignment between the NAEP and Louisiana's science and the environment section may be due to the fact that the Louisiana section includes content on human and technological influence on the environment, while the NAEP covers similar ideas about the use of technological design in its "science practices" section.

### Summary of grade 8 alignment

The Louisiana benchmarks cover many content topics that are not assessed by the NAEP, while most of the Louisiana content in its benchmarks and grade level expectations only partially addresses the NAEP content statements. This is primarily because many Louisiana standards imply NAEP content and because the NAEP is often more detailed in its presentation of content. The overall alignment rating for grade 8 is 2.1, indicating partial alignment.

**Most Louisiana standards for grade 11 fully address the NAEP content statements for grade 12**

## CONTENT ALIGNMENT AT GRADE 12

For grade 12, the NAEP provides 49 distinct content statements (displayed in parentheses in table 3). Twenty-five (51 percent) are fully addressed by Louisiana benchmarks, 23 (47 percent) are partially addressed, and 1 (2 percent) is not addressed.

The average alignment rating for grade 12 is 2.5. The majority of content statements were given ratings of 3, which means that most state standards fully address the NAEP content statements (figure 3 and appendix E).

### Areas of full alignment

More than half the 49 NAEP grade 12 content statements are fully addressed by Louisiana benchmarks and grade level expectations. Sixty-five percent of all physical science content statements are fully addressed, as are 46 percent of life science statements and 31 percent of Earth and space science statements. The level of detail of the Louisiana grade level expectations often matches that of the NAEP standards, and the combination of benchmarks and grade level expectations often warranted a rating of full alignment with a very detailed NAEP statement.

### Areas of partial alignment

Twenty-three NAEP grade 12 content statements (47 percent) have partial alignment, largely because Louisiana benchmarks often imply content explicitly stated by the NAEP and because NAEP content statements are often more detailed than Louisiana's.

Each NAEP content statement is matched to an average of five Louisiana content statements (benchmarks or grade level expectations), since each NAEP standard is highly detailed and incorporates ideas that are put into separate benchmarks and

TABLE 3

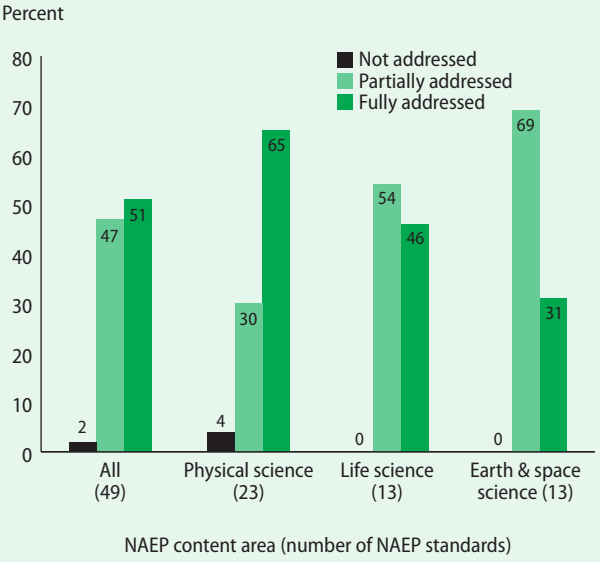
**Average ratings of alignment of Louisiana high school benchmarks and grade level expectations and National Assessment of Educational Progress grade 12 science content statements**

| NAEP content area (number of NAEP standards) | Average rating |
|---|---|
| Overall physical science (23) | 2.6 |
| Matter (7) | 2.7 |
| Energy (9) | 2.4 |
| Motion (7) | 2.7 |
| Overall life science (13) | 2.5 |
| Structures and functions of living systems (7) | 2.1 |
| Changes in living systems (6) | 2.8 |
| Overall Earth and space science (13) | 2.3 |
| Earth and space in time (7) | 2.3 |
| Earth structures (1) | 2.0 |
| Earth systems (5) | 2.4 |
| All content (49) | 2.5 |

*Note:* Rating is based on a scale of 1 to 3, where 1 indicates that state standards do not address the NAEP content statement, 2 that they partially address the NAEP content statement, and 3 that they fully address or exceed the NAEP content statement by the targeted grade level.

FIGURE 3

**The majority of Louisiana high school standards fully address National Assessment of Educational Progress content statements**




grade level expectations by Louisiana. The majority of partially aligned statements were coded "IC," denoting implied content in Louisiana's standards.

NAEP content statements at grade 12 are characteristically detailed and extensive. Each content statement typically contains several sentences, each of which can often be matched to a single Louisiana benchmark. Therefore, much of the alignment between the NAEP grade 12 and Louisiana's grade 11 benchmarks consists of several Louisiana benchmarks and grade level expectations matched and rated with a single NAEP statement.

Raters found that many Louisiana benchmarks imply content that the NAEP addresses in depth. For example, Louisiana's PS-H-B2 describes the nature and importance of radioactive isotopes and nuclear reactions (fission, fusion, radioactive decay), while the NAEP's P12.11 defines fission and fusion, which presumably is implied in descriptions of their nature and importance.

Part of L12.9 was matched with LS-H- B3 but was given an implied content code because mention of altered genes is found in the NAEP but not in Louisiana. E12.6 has content regarding early Earth, including evidence for bacteria and the absence of atmospheric oxygen, while SE-H-A7 and A8 and GLE HS EnvSci.9 deal generally with the biosphere and the evolution and adaptation of plants and animals but do not provide such detailed illustrations of early Earth.

Raters also found that the NAEP's content often provides more detail than do the Louisiana benchmarks. For example, while the NAEP's E12.7 names some of the geological processes of Earth, including earthquakes, volcanic eruptions, the building of mountain chains, and the shifting of continents, Louisiana's matching standards (SE-H-A6, SE-H-A4, ESS-H-C5, GLE EnvSci.5, GLE EarthSci.22) mention changes in Earth's structure more generally.

## Areas of nonalignment

One NAEP content item is unaddressed by Louisiana benchmarks. That item is P12.13, which states,

"The potential energy of an object on Earth's surface is increased when the object's position is changed from one closer to Earth's surface to one farther from Earth's surface."

### Areas where Louisiana benchmarks go beyond the NAEP content statements

More than one-third of Louisiana benchmarks in grade 11 are not covered by the NAEP. The NAEP does not address the 12 Louisiana benchmarks in science as inquiry, 8 of the 29 in physical science, 13 of the 30 in life science, 3 of the 18 in Earth and space science that are used in the state assessments, and 2 of the 12 in science and the environment that are used in the state assessments.

**The Louisiana benchmarks for grade 11 contain many items that are not assessed by the NAEP**

The NAEP does not address the 12 science as inquiry benchmarks because it discusses inquiry in a section separate from the content statements, called "science practices," intended to crosscut all NAEP content. In physical science, the NAEP does not address, for example, several Louisiana benchmarks about chemical reactions (PS-H-D1, D2, D3 and D4). In life science, the NAEP does not address several benchmarks in the category of biological evolution (LS-H-C5, C6 and C7), nor does it address any of the benchmarks in the categories of systems and the behavior of organisms (LS-H-F1, F2, F3, and F4) or personal and community health (LS-H-G1, G2, G3, G4 and G5). The NAEP does not address Louisiana's highly specific Earth and space science benchmark about the geologic development of Louisiana (ESS-H-C3), nor does it address the demonstration of the laws of motion for orbiting bodies (ESS-H-D6). ESS-H-D7 and two science and the environment benchmarks (SE-H-B6 and SE-H-C4) involve human and technological influence on the environment and are not covered by NAEP content statements, which cover similar ideas regarding the use of technological design in the "science practices" section.

### Summary of NAEP grade 12 alignment

The Louisiana benchmarks contain many items that are not assessed by the NAEP. Often, Louisiana benchmarks were noted for their alignment to distinct parts of a more detailed NAEP content statement. Overall, Louisiana is well aligned to the NAEP. Many Louisiana high school standards only partially address the NAEP content statements at grade 12 because they imply NAEP content and because the NAEP is often more detailed and in-depth in its presentation of content. However, there is a generally high alignment between NAEP and Louisiana, and the overall alignment rating is 2.5.

## TEST SPECIFICATIONS ALIGNMENT

The assessment specifications alignment involved two parts: examining the types of items found in the NAEP and in the Louisiana Educational Assessment Program and the Graduation Exit Examination, and comparing the NAEP's distribution of items among the different science strands with that of the Louisiana Educational Assessment Program and the Graduation Exit Examination.

Science is a discipline with a strong tradition of investigation, experimentation, and application of knowledge and skills. Before the 2005 assessment, NAEP science assessments consisted primarily of short-answer, paper-and-pencil questions that were mostly multiple-choice, which can go only so far in assessing skills. To improve the assessment of the range of science knowledge and skills, the last two NAEP science frameworks have expanded the range of item types on the test. In particular, the 2009 NAEP framework takes advantage of advances in educational measurement and the development of computer-based assessments. Due to the varying ways that differing item types assess and reveal what students know and can do, the NAEP 2009 assessment specifications require future NAEP tests to incorporate a range of item types, allowing students to reveal their understanding in ways beyond traditional selected-

response methods. Multiple-choice items, short constructed-response items, extended constructed-response items, hands-on performance tasks, and interactive computer tasks will all be used to more accurately assess student knowledge, thinking, and skills.

Each type of assessment item demands a unique response from students (selecting a response from a set of alternatives, writing an explanation or justification, performing a virtual lab experiment). Individual items may draw on different types of stimuli (verbal, graphic, manipulative) to access the knowledge and skills required or may be scored in a variety of ways (right/wrong, partial credit, human scorers, computer software). By using several types of items the 2009 NAEP science assessment will require students to draw on multiple types of knowledge and a variety of skills for using and expressing that knowledge, thereby giving a more accurate picture of the breadth and depth of their learning. In this study, the following item types from the NAEP were compared with the types in use by the states.

In multiple-choice items, students reflect on the material and then select an answer from a limited number of alternatives. Well constructed multiple-choice items can probe important facts, broad concepts, and themes of science, as well as deductive reasoning skills.

Constructed-response items, in which students answer without reference to a provided list of alternatives, include short constructed-response items and extended constructed-response items. Constructed-response items can provide insight into students' levels of conceptual understanding and assess their ability to communicate about science. They can also be used to probe student ability to generate information related to science content statements and their interconnections (how two or more cyclic events are related). Constructed-response items may be particularly useful for probing the practices of using scientific inquiry or using technological design (interpret given data or provide a solution to a real-world problem).

In hands-on performance tasks, students manipulate selected physical objects and try to solve a scientific problem involving the objects. These exercises, if carefully designed, can probe student abilities to combine science knowledge with the investigative skills reflective of the nature of science and inquiry.

**By using several types of items the 2009 NAEP science assessment will require students to draw on multiple types of knowledge and a variety of skills for using and expressing that knowledge**

Interactive computer tasks in the 2009 NAEP science assessment may involve information search and analysis, empirical investigation, simulation, or concept mapping. The broad purpose of interactive computer tasks in this context is to tap performance expectations that are more advantageously assessed in a virtual format, such as scientific modeling of microscopic or temporal phenomena, repeated experiments, or simulations of hazardous or messy lab situations. Interactive computer tasks are intended as a complement to the hands-on performance tasks, not as a replacement.

The NAEP specifications also include two other types of items, item clusters and predict-observe-explain item sets. Item clusters are groups of related items that provide more in-depth analysis of student performance than would a collection of discrete, unrelated items. They can be particularly useful in exploring student conceptions, predictions, or explanations of the natural world. The predict-observe-explain item sets (White & Gunstone, 1992) describe a situation and ask the student to predict, observe, or explain the outcome, sometimes with additional supporting detail. Predict-observe-explain items may involve using science principles or the cognitive demand of "knowing why (schematic knowledge)." Because these are really ways of clustering items and are not usually included in state test specifications, they were not used for comparison in this study.

The NAEP stipulates that 50 percent of student response time should be spent on multiple-choice items and the other 50 percent on constructed-response items (including short constructed-response, extended-constructed-response, and concept-mapping tasks). Within these two categories are item clusters, predict-observe-explain item sets, hands-on performance tasks, and interactive computer tasks. There will be at least one item cluster, one predict-observe-explain item set, one hands-on performance task, and one interactive computer task at each grade level, and the total number of interactive computer tasks plus hands-on performance tasks will be at least four at each grade level.

The number of score points in the Louisiana tests is the same for grades 4, 8, and 11 (grade 11 is compared to the NAEP grade 12 in this analysis). There are 40 multiple-choice items, 7 short constructed-response items, and 1 extended constructed-response item at each grade. Three of the short answer items and the extended constructed-response item are part of a "comprehensive science task" that is also given at each grade level. Of the combined 47 multiple-choice and short constructed-response items, approximately two-thirds address the NAEP content strands of physical, life, and Earth and space sciences. The remaining items address other science content from the state benchmarks.

Table 4 shows the percentages of various item types found in the NAEP and in Louisiana. The 2009 NAEP will have 50 percent of student response time allocated to multiple-choice items and 50 percent allocated to constructed-response items (short and extended). The current Louisiana tests do not have their item distributions proportioned by student response time, so the table shows the NAEP's proportions of student response time and Louisiana's proportions of items and points. The proportions of items and points are the same for Louisiana grades 4, 8, and 11. The Louisiana test contains mostly multiple-choice items, but it does include short constructed-response items, an extended constructed-response item, and a "comprehensive science task." The distribution of points for Louisiana at all grade levels is fairly similar to the distribution of time for the NAEP; Louisiana is 69 percent multiple-choice and 31 percent constructed-response, while the NAEP is 50 percent multiple-choice and 50 percent constructed-response. Louisiana's test specifications indicate that its tests will include "comprehensive science tasks," which require students to read, use, and react to a scenario that typically includes diagrams, data tables, and graphs, and may require students to complete or interpret data tables or to record observations. This is different from the NAEP hands-on performance task, which requires the manipulation of physical objects in order to solve a scientific problem.

To consider how the state test coverage of the NAEP science topics matched, table 5 shows the proportions of testing time devoted to each of the three content areas for the NAEP and for the

TABLE 4
**Proportions of different item types on the Louisiana science assessment (percent)**

| | NAEP | Louisiana (grades 4, 8, 11) | |
|---|---|---|---|
| NAEP item types | Share of time | Share of total items | Share of total points |
| Multiple-choice items | 50 | 83 | 69 |
| Short constructed-response items | 50 | 15 | 24 |
| Extended constructed-response items | | 2 | 7 |
| Hands-on performance tasks[a] | (≥1) | | |
| Interactive computer tasks[a] | (≥1) | | |

a. Hands-on performance tasks and interactive computer tasks are combination items and can be categorized as multiple-choice or constructed-response.

Louisiana test. The first column of the table lists all the science topic areas that are included on the Louisiana test. The first three topic areas (physical, life, and Earth and space sciences) are those that are covered on the NAEP, while the two topics below those (science as inquiry and science and the environment) are not separately assessed on the NAEP.

Under the column heading for grade 4, three subcolumns are shown. The first shows the proportion of testing time devoted to each of the three NAEP topic areas. The second shows the proportion of points Louisiana allots to each strand , excluding the comprehensive science task, which includes three short-answer questions about science as inquiry and one extended constructed-response item about one of the four content strands (in grades 4 and 8) or two of the four content strands (in grade 11). (The comprehensive science task is excluded from these calculations because it is unknown which of the four content strands it will contain.) The third subcolumn shows the comparison of the proportions devoted to the three NAEP topics, a positive number if the Louisiana test devotes more and a negative number if the NAEP devotes more. This pattern of columns is repeated for middle and high school. Louisiana grade 11 was compared with the NAEP grade 12.

At all grade levels, the proportion of points devoted by Louisiana to each NAEP content strand is less than the proportion of time devoted to each strand by the NAEP. This is because Louisiana allots a significant proportion of its test to science as inquiry and science and the environment, which are not separate strands on the NAEP.

Table 6 ignores the testing time devoted to science as inquiry and science and the environment, which are not separately tested in the NAEP, and shows how the proportions of testing time on the NAEP, for the three NAEP strands, compare with the proportions of points on the state test. These calculations exclude the comprehensive science task because it is not known which of the strands

TABLE 5

**Approximate testing time allocated to different science topics on the Louisiana science assessment (percent)**

| | Grade 4 | | | Grade 8 | | | Grade 12/Grade 11 | | |
|---|---|---|---|---|---|---|---|---|---|
| Content area | NAEP (time) | Louisiana (points) | Difference | NAEP (time) | Louisiana (points) | Difference | NAEP (time) | Louisiana (points) | Difference |
| Physical science | 33 | 21 | –12 | 30 | 21 | –9 | 37.5 | 25 | –13 |
| Life science | 33 | 21 | –12 | 30 | 21 | –9 | 37.5 | 25 | –13 |
| Earth and space science | 33 | 21 | –12 | 40 | 21 | –19 | 25 | 17 | –8 |
| Science as inquiry | 0 | 17 | | 0 | 17 | | 0 | 17 | |
| Science and the environment | 0 | 21 | | 0 | 21 | | 0 | 17 | |

TABLE 6

**Comparison of the proportions of testing time allocated to the National Assessment of Educational Progress science topics (percent)**

| | Grade 4 | | | Grade 8 | | | Grade 12/Grade 11 | | |
|---|---|---|---|---|---|---|---|---|---|
| Content area | NAEP (time) | Louisiana (points) | Difference | NAEP (time) | Louisiana (points) | Difference | NAEP (time) | Louisiana (points) | Difference |
| Physical science | 33 | 33 | 0 | 30 | 33 | +3 | 37.5 | 37.5 | 0 |
| Life science | 33 | 33 | 0 | 30 | 33 | +3 | 37.5 | 37.5 | 0 |
| Earth and space science | 33 | 33 | 0 | 40 | 33 | –7 | 25 | 25 | 0 |

it will contain. At the elementary level, the proportions are the same in the NAEP and in Louisiana. In grade 8, Louisiana devotes 33 percent of its points equally to all three topics, whereas the NAEP emphasizes Earth and space science by allocating 40 percent of testing time to it and only 30 percent to the other two topics. For grade 12, the NAEP devotes more time to the physical and life science strands, and Louisiana also gives more points to the physical and life science strands. The Louisiana proportions match the NAEP proportions almost exactly.

## APPENDIX A
## THE DOCUMENTS COMPARED

This alignment study used the science framework for the 2009 National Assessment of Educational Progress and the accompanying science assessment and item specifications as its baseline for comparison (National Assessment Governing Board, 2006). The two NAEP documents were developed by a steering and a planning committee made up of leaders in science, science education, general education, assessment, and various public constituencies. The documents went through public and committee review processes before finally being adopted and published in 2006 by the National Assessment Governing Board. The 2009 framework will guide the test development until approximately 2017.

NAEP assessments in science are administered across all states in the nation according to a statistical sampling plan and to some selected urban areas. The NAEP tests students at grades 4, 8, and 12 every four to five years and is intended to provide a snapshot of what students at those grades know and can do in science. In addition, the resulting data on student knowledge and performance have been accompanied by background information that allows analysis of student demographic and instructional factors related to achievement. The assessments have been designed to allow comparisons of student performance over time and among subgroups of students according to region, parental education, gender, and race/ethnicity.

The NAEP 2009 science assessment will include two separately timed, 25-minute sections of science items and extra 30-minute sections for hands-on performance tasks and interactive computer tasks, which will be given only to a subset of all students sampled. There will be multiple test booklet forms, and a matrix sampling design will be used so that students do not all receive the same items. Instead of detailing the number of test items that will fall in various categories, the NAEP outlines its distribution of items by "student response time" and stipulates that 50 percent of student response time will be used in answering multiple-choice items and the other 50 percent in constructed-response items. Constructed-response items will include short constructed-response, extended constructed-response, and concept-mapping tasks. In addition, at least one of each of the following item types must be used at each grade level: item clusters, predict-observe-explain item sets, hands-on performance tasks, and interactive computer tasks. Table A1 shows the stipulated distribution of items for the NAEP 2009 as a percentage of student response time:

The NAEP science content used in this study is shown in detail in Chapter Two: Science Content, which is extracted from the science assessment and item specifications for the 2009 NAEP document.

This alignment study was intended to compare the NAEP framework to the corresponding documents used to develop the state science assessment. Louisiana statewide exams draw not only from

TABLE A1
**National Assessment of Educational Progress distribution of items and standards by content area and grade**

| | Grade 4 | | Grade 8 | | Grade 12 | |
|---|---|---|---|---|---|---|
| Content area | Share of response time (percent) | Number of content standards | Share of response time (percent) | Number of content standards | Share of response time (percent) | Number of content standards |
| Physical science | 33.3 | 15 | 30.0 | 16 | 37.5 | 23 |
| Life science | 33.3 | 7 | 30.0 | 12 | 37.5 | 13 |
| Earth and space science | 33.3 | 11 | 40.0 | 15 | 25.0 | 13 |

the Louisiana Educational Assessment Program assessment guides but also from the grade level expectations. Therefore, this review used the Louisiana Educational Assessment Program's assessment guides in science (Louisiana Department of Education, 2006b) for grades 4, 8 and 11, and the grade level expectations at grades pre-K through high school (Louisiana Department of Education, 2006a). The assessment guides contain not only benchmarks but also test specification blueprints, which indicate the breakdown of test items by strand and type. Thus, the assessment guides were used both for the content analyses in this alignment and the test specifications alignment. The NAEP is administered to students in grades 4, 8, and 12, while Louisiana gives its statewide tests in grades 4, 8, and 11. Therefore, in comparing Louisiana's Educational Assessment Program assessment guide to the NAEP, the Louisiana benchmarks at grades 4, 8, and 11 were used in an effort to compare the Louisiana standards that were most likely to appear on the assessments with the NAEP assessment standards.

The Louisiana Educational Assessment Program and the Graduation Exit Examination form the state's criterion-referenced testing program. The Louisiana Educational Assessment Program is given at grades 4 and 8, and the Graduation Exit Examination is initially given at grades 10 and 11 (Louisiana Department of Education, 2003). The program was developed to align directly with the Louisiana content standards, to be as rigorous as the NAEP, and to assign students one of five achievement ratings (advanced, mastery, basic, approaching basic, or unsatisfactory). The topic of science was added to the Louisiana Educational Assessment Program in grades 4 and 8 in the spring of 2000 and to the Graduation Exit Examination in spring 2002. Achievement levels in mathematics and English language arts at grades 4 and 8 have a direct bearing on whether or not students can progress to subsequent grade levels. High school students must score "approaching basic" or above in both English language arts and mathematics and on either the science or the social studies test to be eligible for a high school diploma.

TABLE A2

**Number of multiple-choice, short-answer, and extended constructed-response items by strand—Louisiana grades 4 and 8**

| Strand | Multiple-choice (1 point) | Short answer (2 points) | Extended constructed-response items (4 points) | Score points |
|---|---|---|---|---|
| 1. Science as inquiry | 8 | 0 | | 8 |
| 2. Physical science | 8 | 1 | | 10 |
| 3. Life science | 8 | 1 | | 10 |
| 4. Earth and space science | 8 | 1 | | 10 |
| 5. Science and the environment | 8 | 1 | | 10 |
| *Comprehensive science task* | | | | |
| 1. Science as inquiry | | | | |
| Dimension 1 (questioning, planning, doing, and recording) | | 1 | | 2 |
| Dimension 2 (interpreting and communicating) | | 2 | | 4 |
| 2. Physical science | | | 1 (in one of the four strands) | 4 |
| 3. Life science | | | | |
| 4. Earth and space science | | | | |
| 5. Science and the environment | | | | |
| Total score points | 40 | 14 | 4 | 58 |

The Louisiana Educational Assessment Program and the Graduation Exit Examination science tests have three parts. Session 1 assesses all five stipulated science strands using multiple-choice questions. Session 2 includes four short-answer questions that assess four content strands (excluding science as inquiry). Session 3 is a comprehensive science task, which includes three science as inquiry short-answer questions and a four-point constructed-response question assessing the science content of the task. Tables A2 and A3 illustrate the distribution of items by strand.

For this study, both the Louisiana benchmarks found within the Louisiana assessment guides and the Louisiana grade level expectations were used in comparison with the NAEP's content statements. The distribution of the number of benchmarks and grade level expectations found at grades 4 and 8 and in high school are shown in tables A4 and A5. Generally, and most noticeably at the high school level, there are more grade level expectations than there are benchmarks.

NAEP grade 4 and grade 8 content statements were primarily compared with Louisiana grade 4 and grade 8 benchmarks and grade level expectations. However, in general, if there was a Louisiana benchmark or grade level expectation that addressed an NAEP content statement at an earlier or later grade, that was noted in the alignment tables in appendixes C–E. The NAEP grade 12 content statements were compared with the Louisiana Educational Assessment Program benchmarks for grades 9–12 (excluding those that the assessment guide says are not assessed) and the full set of Louisiana high school grade level expectations.

TABLE A3

**Number of multiple-choice, short-answer, and extended constructed-response items by strand—Louisiana Graduation Exit Examination grade 11**

| Strand | Multiple-choice (1 point) | Short answer (2 points) | Extended constructed-response items (4 points) | Score points |
|---|---|---|---|---|
| 1. Science as inquiry | 8 | 0 | | 8 |
| 2. Physical science | 10 | 1 | | 12 |
| 3. Life science | 10 | 1 | | 12 |
| 4. Earth and space science | 6 | 1 | | 8 |
| 5. Science and the environment | 6 | 1 | | 8 |
| *Comprehensive science task* | | | | |
| 1. Science as inquiry | | | | |
| Dimension 1 (questioning, planning, doing, and recording) | 1 | | | 2 |
| Dimension 2 (interpreting and communicating) | 2 | | | 4 |
| 2. Physical science | | | 1 (in two of the four strands) | 4 |
| 3. Life science | | | | |
| 4. Earth and space science | | | N/A | |
| 5. Science and the environment | | | | |
| Total score points | 40 | 14 | 4 | 58 |

TABLE A4

**Distribution of benchmarks and grade level expectations by strand—grades 4 and 8**

| | Grade 4 | | Grade 8 | |
|---|---|---|---|---|
| Strand | Number of benchmarks | Number of grade level expectations | Number of benchmarks | Number of grade level expectations |
| Science as inquiry | 13 | 22 | 15 | 40 |
| Physical science | 16 | 17 | 22 | 7 |
| Life science | 13 | 15 | 16 | 0 |
| Earth and space science | 13 | 15 | 23 | 42 |
| Science and the environment | 5 | 3 | 10 | 4 |
| Total | 60 | 72 | 86 | 93 |

TABLE A5

**Distribution of benchmarks and grade level expectations by strand—Graduation Exit Examination and high school grade level expectations**

| Graduate Exit Examination | | High school | |
|---|---|---|---|
| Strand | Number of benchmarks | Strand | Number of grade level expectations |
| Science as inquiry | 12 | Science as inquiry | 16 |
| Physical science | 29 | Physical science | 50 |
| | | Chemistry | 47 |
| | | Physics | 35 |
| Life science | 30 | Biology | 42 |
| Earth and space science | 18 | Earth science | 30 |
| Science and the environment | 12 | Environmental science | 28 |
| Total | 101 | Total | 248 |

## APPENDIX B
## HOW THE STUDY WAS CONDUCTED

The chief research questions driving this study were these: "To what extent do current state assessment standards cover the content on which NAEP 2009 assessments will be based?" and "To what extent do current state assessment specifications align with the NAEP 2009 assessment specifications?"

The methodology used to answer these questions followed the successful pattern of a similar study conducted by WestEd in New England, which examined the alignment of math and reading standards with the NAEP. The methodology developed by WestEd for the New England study was designed to include all the most prominent alignment methodologies, discussed below. Thus far, alignment studies and methods have focused on aligning standards with tests, whereas the objective of this study was to compare one set of assessment standards and specifications with another. In this study, however, the methodology is based upon methodologies for aligning standards to tests, because similar principles are used in both types of alignments.

Eight independent alignment methodologies are examined in *Imperfect Matches: The Alignment of Standards and Tests* (Rothman, 2003), which describes methodologies by Norman L. Webb, Karen K. Wixson, Andrew C. Porter, Achieve, the Buros Center for Testing, the American Association for the Advancement of Science's Project 2061, CRESST, and SRI International.

- Webb's method involves evaluating the degree to which consistent content categories or content strands are found between the standards and assessments (categorical concurrence), the degree to which the standards and assessments cover content to the same depth and have similar cognitive demands (depth-of-knowledge consistency), the degree to which assessments cover the same range of content as the corresponding standards (range-of-knowledge correspondence), and the degree to which the distribution of assessment items matches the distribution of content standards (balance of representation) (Webb, 1997, 1999).

- Wixson's method (Wixson et al., 2002) is a modified version of Webb's and includes range-of-knowledge correspondence, balance of representation, coverage (whether each objective was covered by at least one assessment item), depth-of-knowledge consistency, and the extent to which the philosophy underlying the assessment matches the philosophy of the standards (structure of knowledge comparability).

- Porter's method (Porter, 2002) involves a matrix with rows representing topics and columns representing categories of cognitive demand, in which reviewers record values to represent the level of alignment.

- Achieve's method (Achieve, 2003) involves examining test blueprints to see whether they adequately reflect the map of test items to standards. It also involves examining the quality of the match between an assessment item and its corresponding standard (content centrality), the degree to which an item appropriately assesses the "performance" or cognitive demand presented by a standard (performance centrality), the degree to which the assessment's difficulty matches the difficulty presented by the standard (challenge), the degree to which the assessment's emphasis on content matches the standard's emphasis on content (balance), and the degree to which the assessment's breadth of content matches the standard's breadth of content (range).

- The Buros Center's methodology uses teachers to record four levels of alignment of items to standards (Impara, 2001).

- The Project 2061 methodology, developed by the American Association for the

Advancement of Science, includes independently rating materials and then meeting in two-person teams to reach a consensus that would be reconciled by Project 2061 staff (Stern & Ahlgren, 2002).

- The CRESST methodology includes identifying corresponding content topics, rating the centrality of the item to the topic, and rating the depth-of-knowledge level (Herman, Webb, & Zuniga, 2003).

- SRI International created codes for various portions of standards that were used to perform the alignment and to determine the degree of matching (Kreikemeier, Quellmalz, & Haydel, 2004).

The WestEd New England methodology was designed to include the major alignment methodologies. The developed methodology involved a "quality review" of grade level expectations within grades and across grades. Within grades a methodology was employed to account for depth of knowledge, breadth of knowledge, clarity, consistency, reasonableness, and assessability. Across grades, the study examined categorical concurrence, consistency, and assessability.

The study also involved an "alignment review" in which a methodology of examining gaps, order, depth, and breadth was used to compare the under-review grade level expectations with external referents. More specifically, the first step in the alignment review was to perform "gap analyses." Reviewers were to identify content in the grade level expectations that was absent in the external referent and content in the external referent absent in the grade level expectations. Reviewers then examined "order" to determine whether grade level expectations were included at the same grade level as matching content in the external referent. Last, reviewers examined "depth and breadth" to determine whether the content of the grade level expectations reflected the intended depth and breadth of the external referent. Because the alignment study in this report, which compares Louisiana with the NAEP, focuses only on examining alignment between Louisiana assessment standards and specifications and NAEP 2009 assessment standards and specifications, only part of WestEd's New England study methodology was used.

In this study, reviewers followed the methodology of the portion of the previous study examining alignment between two sets of standards. Test blueprints were examined to find correspondence between the two documents, which follows the methodology of Achieve. Reviewers performed gap analyses to identify content included in one set of standards but not the other, identified issues of order so they could reveal differences in the grade levels at which standards appear, and examined depth-of-knowledge and range-of-knowledge correspondence (following Webb's and Wixson's criteria) to determine whether there is a match between the state and the NAEP in the level of detail, cognitive demands, and range of content covered. A coding scheme (similar to that of the Buros Center) was used to indicate alignment issues and reviewer ratings, and a matrix-like format (similar to Porter's method) was created to facilitate alignment.

Reviewers attended several training sessions and then met in teams of two to reach consensus on ratings (similar to the Project 2061 method). This consensus method was designed to create one consensus rating per NAEP standard with the help of a moderator and was not intended to allow for disagreements. This methodology was determined to be best suited to the scope and timing of this study. The consensus methodology is designed to highlight areas for states to examine, not to gather large amounts of data, record multiple ratings, or measure inter-rater reliability.

## The content reviews

State standards detail what students are expected to know and do, and as such they are a crucial area for examination. Assessment standards form the basis from which test items are conceived and

developed, and they ultimately determine the content that appears on tests. Therefore, this study compared state assessment standards to NAEP content statements through the completion of content reviews.

The content reviews were conducted by a team of six science educators under the leadership of a senior reviewer. The team was directed by Dr. Timms, who is a senior assessment researcher in the mathematics, science and technology program at WestEd and managing director of the Center for Assessment and Evaluation of Student Learning. The senior reviewer is a retired biology and AP biology teacher with 37 years of classroom experience, is a recipient of the Outstanding Biology Teacher Award for the state of California, and has worked in various teacher professional development capacities, including work with the Teacher Assessment Project and the National Board for Professional Teaching Standards.

The six science educators were chosen based on recommendations by the senior reviewer. The team was composed of individuals with science education experience ranging from serving on the National Board for Professional Teaching Standards' Science Committee and co-chairing the California Science Teachers Association Conference to being a technology instructor at a local university to developing widely used science curricula. All six reviewers are current, credentialed middle and high school science teachers. The reviewers have science teaching experience covering the full range of science content areas. Currently, four of the reviewers teach integrated science, one teaches Earth science, three teach biology, one teaches chemistry, and another is a middle school science teacher. The team was also supported by two research assistants.

To ensure that the review was systematic, WestEd developed a crosswalk instrument that was used to evaluate the alignment of the state assessment standards with the content standards contained in the new NAEP 2009 science framework. These crosswalk instruments contained NAEP standards at the appropriate grade level in the leftmost column, blank cells in the next column for reviewers to fill in corresponding state assessment standards, another column for providing ratings, a column for assigning codes, and a final column for various notes. Completed crosswalk instruments, or "alignment tables," can be found in appendices C–E. An extract of a completed crosswalk instrument is given, along with explanations, in figure B1.

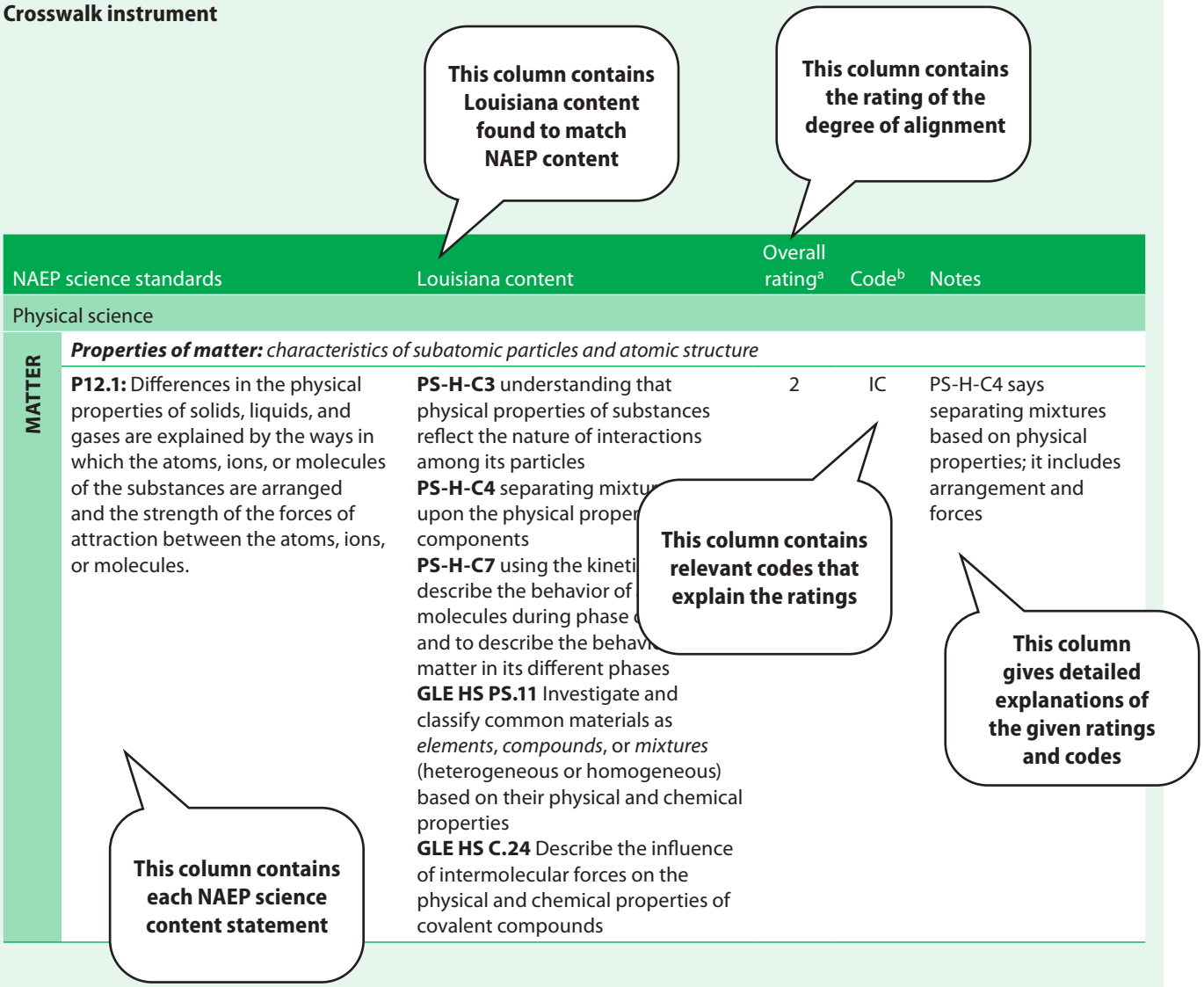
Louisiana's benchmarks contain coding schemes that were followed by the reviewers. The benchmark coding scheme follows this pattern: strand, grade level, benchmark. For example, "LS-M-A1" indicates life science, middle school, and benchmark A1. The following codes were used to indicate various strands for the benchmarks:

SI = Science as inquiry
PS = Physical science
LS = Life science
ESS = Earth and space science
SE = Science and the environment

WestEd developed its own coding scheme for the grade level expectations, which follows this pattern: grade level, strand, grade level expectation number. For example, "GLE HS PS.11", indicates that this statement is a grade level expectation (as opposed to a benchmark), that it is found in high school, that it is physical science, and that its grade level expectation number is 11 in the high school physical science portion of the document. The following codes were used to indicate various strands in the grade level expectations:

SI = Science as inquiry
PS = Physical science
LS = Life science
ESS = Earth and space science
SE = Science and the environment
Bio = Biology
EarthSci = Earth science
EnvirSci = Environmental science
C = Chemistry
P = Physics

FIGURE B1
**Crosswalk instrument**




| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Physical science | | | | |
| MATTER | ***Properties of matter:*** *characteristics of subatomic particles and atomic structure* | | | |
| **P12.1:** Differences in the physical properties of solids, liquids, and gases are explained by the ways in which the atoms, ions, or molecules of the substances are arranged and the strength of the forces of attraction between the atoms, ions, or molecules. | **PS-H-C3** understanding that physical properties of substances reflect the nature of interactions among its particles<br>**PS-H-C4** separating mixtu upon the physical proper components<br>**PS-H-C7** using the kineti describe the behavior of molecules during phase and to describe the behav matter in its different phases<br>**GLE HS PS.11** Investigate and classify common materials as *elements*, *compounds*, or *mixtures* (heterogeneous or homogeneous) based on their physical and chemical properties<br>**GLE HS C.24** Describe the influence of intermolecular forces on the physical and chemical properties of covalent compounds | 2 | IC | PS-H-C4 says separating mixtures based on physical properties; it includes arrangement and forces |

The rating scale for the "overall rating" column of the crosswalk instrument was:

1—State standards do not address NAEP content statement
2—State standards partially address NAEP content statement
3—State standards fully address or exceed NAEP content statement by targeted grade level

When there was partial or nonalignment (ratings 2 or 1), the reviewers used a letter coding scheme to indicate the reason for the lack of alignment. The coding scheme was:

| | |
|---|---|
| **IC**—Implied content | The content seems to be implied as part of the standard, but it is not explicitly stated. |
| **LG**—Content covered at a lower grade level | The NAEP standard is partially or fully covered at a lower state grade level. |
| **HG**—Content covered at a higher grade level | The NAEP standard is partially or fully covered at a higher state grade level. |
| **MC**—More content | The NAEP standard contains more content than do corresponding state standards. |
| **MD**—More detailed content | The NAEP standard contains content that is more detailed than corresponding state standards. |

Reviewers also added explanatory notes to the alignment ratings to indicate precisely the reason for the partial or nonalignment. There were separate instruments for grades 4, 8, and 12, and within each grade level the content was divided into Earth and space science, life science, and physical science categories. Based on a combination of their scientific and grade level experience, the six reviewers worked in teams of two reviewers per grade level. When the NAEP and state grades being compared did not match (as when comparing NAEP grade 12 with Louisiana grade 11), content statements were considered to be at the same grade for the assignment of alignment ratings (1-3) and codes (such as HG and LG).

To ensure the consistent application of the crosswalk instrument by each reviewer, the alignment team attended training sessions spread over several weeks and conducted by Dr. Timms. The training comprised four sessions. Session one included a review of a previous WestEd alignment study to allow teachers to understand the scope of the project and the methodology. The team was also given an introduction to the NAEP standards and then asked to carefully read the NAEP framework standards document before the second session. The second training session included a review and discussion of the NAEP standards and an overview of each of the REL Southwest Region's state assessment standards. Reviewers were then asked to complete an in-depth reading of one of the states' assessment standards. During the third training session, reviewers were introduced to the crosswalk instrument and asked to use it to begin performing an alignment. Reviewers then individually completed an alignment for one state.

During the final training session, the teams at each grade level met to practice consensus-building and establish the criteria for assigning each rating. One criterion was to compare one NAEP standard with as many state standards as possible and to assign an overall alignment rating based upon the sum of all state standards compared with the single NAEP standard in question. Another criterion was to give a rating of 2 for alignments in which the state standard addressed only one portion (sometimes one sentence) of the NAEP statement. A third criterion was to assign ratings of 2 to alignments for which the NAEP contained more content or more detailed content than the state, or for which the state appeared to imply but not explicitly state the content found in the NAEP. If a matching standard was found at a higher state grade level than the NAEP grade level, a rating of 2 was given. If a matching state standard was found at a lower grade level but did not appear to fully address the NAEP standard, a rating of 2 was also given.

As part of the stipulated methodology, the reviewers first conducted independent reviews without consulting their partners. Each began with a review of the set of state standards to get an overall impression of their content and structure. Next, the reviewer used the crosswalk instrument to do a more detailed examination starting with a NAEP content statement and then searching the state standards for those that covered all or part the same content. The reviewer continued in this way, systematically matching the state content standards to the NAEP content statements and recording the results in the crosswalk instrument table. After all the NAEP content statements had been covered, the reviewer applied the three-point rating system to determine the level of alignment for each NAEP content statement.

When both reviewers for a grade level had completed their individual reviews, they met under the guidance of the senior reviewer to compare their ratings and reach a consensus. When they disagreed on which state standard(s) matched a particular NAEP content statement or their ratings were not the same, they re-examined the content in question and discussed their differing viewpoints. The purpose was to reach a consensus so that there was a single alignment table for each grade level that represented their combined review. The senior reviewer moderated the discussion to reinforce the established rating criteria and help reviewers achieve consensus. The alignment tables are shown in detail in appendixes C–E.

When the consensus alignment tables were complete, a WestEd researcher summarized them quantitatively by calculating the average ratings organized by each of the three major NAEP content areas of physical science, life science, and Earth and space science. These average ratings are intended to be summaries of how the state's assessment content matches the NAEP content statements and to allow the reader to quickly identify possible areas for revision. In addition, the researcher wrote a report on the results, which summarized the areas of full alignment, partial alignment, and nonalignment, as well as areas where the state standards went beyond the NAEP content statements.

## Test specifications review

In addition to examining content, this study compared the state assessment specifications with the NAEP 2009 test and item specifications. It was deemed important for this study to perform a review of assessment specifications because the way a test is structured and implemented often has implications for what the test is able to reveal about student understanding. The NAEP calls for a variety of test items due to the fact that different types of items demand varying levels of cognition, knowledge, and reasoning (National Assessment Governing Board, 2006). Thus, it is important to examine the extent to which states are attempting to develop assessment items that will provide an accurate picture of what students know and can do across the range of science content and skills. In addition, it was important to examine the proportion of time that students are expected to spend on each content strand of the NAEP and the Louisiana Educational Assessment Program and Graduation Exit Examination. Examining the Louisiana Educational Assessment Program and the Graduation Exit Examination's and the NAEP's distributions of items in these science strands creates a snapshot of the extent to which the breadth of content in Louisiana matches that in the NAEP.

Since the final NAEP 2009 tests have not yet been developed, it is currently possible only to compare the current state science assessment specifications with the stipulated specifications of the future NAEP 2009 science assessment. Accordingly, the translation of standards to actual test items and the comparison of items would also be important, but these comparisons will not be possible until the public release of the NAEP 2009 assessments. Therefore, this report details analyses of the available information on state and NAEP test items, which includes item types and item distribution.

For the purpose of examining assessment specifications, WestEd researchers compared parts of the science assessment and item specifications for the 2009 NAEP document with the test blueprints for Louisiana's science assessments, found in the assessment guides for grades 4, 8, and 11.

The NAEP science assessment and item specifications is a detailed document that covers the science content, science practices, generation and interpretation of items, types of items, and administration of the assessment. For this study the review of the test specifications focused on two main things: the types of items used in the state assessment and the proportions of time that students spend on each of the main science topic areas of the NAEP. WestEd researchers used test blueprints and assessment specifications from the state and the NAEP to compare types of items and the distribution of items in each science content strand. First, differences between the NAEP and the state were examined for the types of items required on the tests (multiple-choice, constructed-response, and so on). Next, differences in the approximate amount of student time spent on each content strand (physical, life, and Earth and space sciences) were examined.

# APPENDIX C
# CONTENT ALIGNMENT FOR GRADE 4

TABLE C1
**Alignment of National Assessment of Educational Progress grade 4 science and Louisiana grade 4 benchmarks and grade level expectations**

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Physical science | | | | |
| **MATTER** | ***Properties of matter:*** *physical properties common to all objects and substances and physical properties common to solids, liquids and gases* | | | |
| **P4.1:** Objects and substances have properties. Weight (mass) and volume are properties that can be measured using appropriate tools. | **PS-E-A1** observing, describing, and classifying objects by properties (size, weight, shape, color, texture, and temperature)<br>**GLE PS 3.18** Compare and classify objects on properties determined through experimentation (e.g., ability to conduct electricity, tendency to float or sink in water)<br>**PS-E-A2** measuring properties of objects using appropriate materials, tools, and technology<br>**GLE PS 4.23** Determine linear, volume, and weight/mass measurements by using both metric system and U.S. system units to compare the results<br>**GLE PS 3.19** Select the appropriate metric system and U.S. system tools for measuring length, width, temperature, volume, and mass<br>**GLE PS 3.20** Measure temperature by using Fahrenheit and Celsius thermometers and compare results<br>**PS-E-A3** observing and describing the objects by the properties of the materials from which they are made (paper, wood, metal)<br>**GLE PS 3.21** Compare common objects and identify the original material from which they are made (e.g., paper, pencil, comb) | 3 | | LEAP includes qualitative too |

(CONTINUED)

TABLE C1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 4 science and Louisiana grade 4 benchmarks and grade level expectations**

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| MATTER | **P4.2:** Objects vary in the extent to which they absorb and reflect light and conduct heat (thermal energy) and electricity. | **PS-E-C2** investigating and describing how light travels and what happens when light strikes an object (reflection, refraction, and absorption)<br>**GLE PS 4.31** Diagram what happens to white light as it passes through a prism<br>**GLE PS 4.32** Describe how light bends or refracts when traveling through various materials (e.g., pencil in a glass of water)<br>**GLE PS 3.28** Describe the reflection/absorption properties of various colored objects<br>**PS-E-C3** investigating and describing different ways heat can be produced and moved from one object to another by conduction<br>**GLE PS 4.33** Describe how heat energy moves through a material by conduction<br>**PS-E-C4** investigating and describing how electricity travels in a circuit<br>**GLE PS 4.36** Test and classify materials as *conductors* and *insulators* of electricity<br>**GLE PS 3.29** Determine which materials insulate best by using experimental data<br>**GLE PS 3.30** Demonstrate and explain the movement of electricity in closed and open circuits | 3 | IC | Refraction is added in LA<br>Benchmarks imply electrical conductivity but it is addressed in GLE PS 4.36 |

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| MATTER | **P4.3:** Matter exists in several different states; the most commonly encountered are solid, liquid, and gas. Each state of matter has unique properties. For instance, gases are easily compressed while solids and liquids are not. The shape of a solid is independent of its container; liquids and gases take the shape of their containers. | **PS-E-A4** describing the properties of the different states of matter and identifying the conditions that cause matter to change states<br>**GLE** PS 1.16 Observe and describe common properties of solids, liquids, and gases<br>**GLE PS 4.24** Illustrate how heating/cooling affects the motion of small particles in different phases of matter<br>**PS-E-A2** measuring properties of objects using appropriate materials, tools, and technology<br>**GLE PS 2.16** Measure weight/mass and volume of a variety of objects and materials by using a pan balance and various containers<br>**PS-E-C1** experimenting and communicating how vibrations of objects produce sound and how changing the rate of vibration varies the pitch<br>**GLE PS 3.27** Use the words *high/low* to compare the pitch of sound and the words *loud/soft* to compare the volume (amplitude) of sound<br>**GLE PS 3.22** Investigate and explain conditions under which matter changes physical states: heating, freezing, evaporating, condensing, boiling<br>**GLE PS 5.5** Describe the properties and behavior of water in its solid, liquid, and gaseous phases (states) | 3 | IC | Benchmarks don't specify solid/liquid/gas, but GLE 1.16 does<br>Benchmarks don't specify relation to containers but GLE 2.16 does<br>LEAP benchmarks specify conditions which cause matter to change state, NAEP doesn't |
| | **P4.4:** Some objects are composed of a single substance; others are composed of more than one substance. | **PS-E-A5** creating mixtures and separating them based on differences in properties (salt, sand)<br>**GLE PS 4.25** Describe various methods to separate mixtures (e.g., evaporation, condensation, filtration, magnetism) | 2 | IC | NAEP clarification (assuming it is referring to compounds, not atoms, then these align as 'separating mixtures')<br>Nevertheless "pure" substance is not identified, although implied<br>This would be a "3" if clarified what a pure substance (compound) is as compared to a mixture (combine w/ phys props?) |

(CONTINUED)

TABLE C1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 4 science and Louisiana grade 4 benchmarks and grade level expectations**

| | NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| MATTER | **P4.5:** Magnets can repel or attract other magnets. They can also attract certain nonmagnetic objects at a distance. | **PS-E-C5** investigating and communicating that magnetism and gravity can exert forces on objects without touching the objects<br>**GLE PS 1.23** Identify materials attracted by magnets<br>**GLE PS 1.24** Determine, through experimentation, which poles of magnets are attracted to each other and which poles repel each other<br>**PS-M-B2** recognizing different forces and describing their effects (gravity, electrical, magnetic)<br>**PS-E-A1** observing, describing, and classifying objects by properties (size, weight, shape, color, texture, and temperature)<br>**GLE PS K.14** Determine whether objects are magnetic or nonmagnetic<br>**GLE PS 3.23** Demonstrate how force is a *push* or a *pull* by using students' bodies, toy cars, or balls<br>**GLE PS 3.24** Explain how the amount and direction of force exerted on an object (e.g., push, pull, friction, gravity) determine how much the object will move | 2 | HG<br>IC | LEAP addresses magnetism with gravity as a force - non-magnetic objects studied in Kindergarten GLE |
| | ***Changes in matter:*** *changes of state* | | | | |
| | **P4.6:** One way to change matter from one state to another and back again is by heating and cooling. | **PS-E-A4** describing the properties of the different states of matter and identifying the conditions that cause matter to change states<br>**GLE PS 4.24** Illustrate how heating/cooling affects the motion of small particles in different phases of matter | 3 | | Conditions that cause matter to change state include heating/cooling but could also imply pressure<br>p. 3-25 The benchmark Q asks about heating |

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Physical science | | | | |
| ENERGY | ***Forms of energy:*** *examples of forms of energy* | | | |
| **P4.7:** Heat (thermal energy), electricity, light, and sound are forms of energy. | **PS-E-C6** exploring and describing simple energy transformations<br>**GLE PS 4.28** Explain the relationship between volume (amplitude) of sound and energy required to produce the sound<br>**GLE PS 4.39** Describe energy transformations (e.g., electricity to light, friction to heat)<br>**GLE PS 3.31** Compare and describe the common forms of energy and explain how they are used in everyday life (e.g., light, electricity, heat, mechanical)<br>**GLE PS 3.32** Give examples of how energy can be used to move or lift objects<br>**GLE PS 3.33** Identify simple machines and the tasks they make possible<br>**PS-E-C7** exploring and describing the uses of energy at school, home, and play<br>**PS-M-C1** identifying and comparing the characteristics of different types of energy<br>**GLE PS 5.10** Compare potential and kinetic energy and give examples of each<br>**GLE 5.11** Classify energy resources as *renewable*, *non-renewable*, or *inexhaustible* | 3 | IC | LEAP doesn't list heat, electricity, etc, but to explore & describe energy in our lives, these would be included and implies kinetic energy too<br>The GLEs confirm above |

(CONTINUED)

TABLE C1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 4 science and Louisiana grade 4 benchmarks and grade level expectations**

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| ENERGY | **P4.8:** Heat (thermal energy) results when substances burn, when certain kinds of materials rub against each other, and when electricity flows though wires. Metals are good conductors of heat (thermal energy) and electricity. Increasing the temperature of any substance requires the addition of energy. | **PS-E-C3** investigating and describing different ways heat can be produced and moved from one object to another by conduction<br>**GLE PS 4.34** Give examples of ways heat can be generated through friction (e.g., rubbing hands)<br>**GLE PS 4.35** Give examples of ways heat can be produced by conversion from other sources of energy<br>**GLE PS 1.22** Identify some examples where heat is released (e.g., burning candles, rubbing hands, running)<br>**GLE PS 4.33** Describe how heat energy moves through a material by conduction<br>**GLE PS 3.29** Determine which materials insulate best by using experimental data<br>**PS-E-C4** investigating and describing how electricity travels in a circuit<br>**GLE PS 4.36** Test and classify materials as *conductors* and *insulators* of electricity<br>**PS-E-C6** exploring and describing simple energy transformations<br>**GLE PS 4.39** Describe energy transformations (e.g., electricity to light, friction to heat)<br>**PS-E-A3** observing and describing the objects by the properties of the materials from which they are made (paper, wood, metal)<br>**GLE PS 2.18** Observe, describe, and record the characteristics of materials that make up different objects (e.g., metal, nonmetal, plastic, rock, wood, paper)<br>**GLE PS 3.31** Compare and describe the common forms of energy and explain how they are used in everyday life (e.g., light, electricity, heat, mechanical)<br>**GLE PS 3.32** Give examples of how energy can be used to move or lift objects<br>**GLE PS 3.33** Identify simple machines and the tasks they make possible<br>**GLE PS 3.30** Demonstrate and explain the movement of electricity in closed and open circuits | 2 | IC<br>MC | Benchmark says, "ways heat can be produced", which implies but does not specify burn, rub, electricity. However, GLEs address this.<br>PS-E-C4 - "how electricity travels"—metal wire would have to be used but isn't stated<br>GLE PS 4.39 electricity to heat implied<br>There is still no match to "Increasing the temp…addition of energy" sentence although it is implied in GLE PS 4.35<br>This could be a "3" if it specified that increasing the temp when conversion is occurring requires additional energy |

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| ENERGY | **P4.8 (continued)** | **PS-M-C5** investigating and describing the movement of heat and the effects of heat in objects and systems<br>**GLE PS 5.14** Identify other types of energy produced through the use of electricity (e.g., heat, light, mechanical) | 2 | IC<br>MC | (see page 30) |
| | **P4.9:** Light travels in straight lines. When light strikes substances and objects through which it cannot pass, shadows result. When light travels obliquely from one substance to another (air and water), it changes direction. | **PS-E-C2** investigating and describing how light travels and what happens when light strikes an object (reflection, refraction, and absorption)<br>**GLE PS 4.31** Diagram what happens to white light as it passes through a prism<br>**GLE PS 4.32** Describe how light bends or refracts when traveling through various materials (e.g., pencil in a glass of water)<br>**GLE PS 2.23** Change the direction of light by using a mirror and/or lens<br>**GLE PS 2.24** Describe how light behaves when it strikes objects and materials (e.g., transparent, translucent, opaque)<br>**PS-E-B3** describing an object's motion by tracing and measuring position over time<br>**GLE PS 3.25** Observe and analyze motion and position of objects over time (e.g., shadows, apparent path of the Sun across the sky)<br>**GLE PS 3.28** Describe the reflection/ absorption properties of various colored objects | 2 | IC | LEAP benchmark says "how light travels" not "in straight lines" as in NAEP. It may well be taught but it is still not defined<br>Benchmarks don't mention shadows but shadows & opaque are found in grades 2 and 3 GLEs<br>This could be a "3" if the wording were changed from "how light travels" to "how light travels in straight lines"<br>LEAP has reflection & absorption in addition NAEP defines refraction, LEAP has the word |
| | **P4.10:** Vibrating objects produce sound. The pitch of sound can be varied by changing the rate of vibration. | **PS-E-C1** experimenting and communicating how vibrations of objects produce sound and how changing the rate of vibration varies the pitch<br>**GLE PS 4.28** Explain the relationship between volume (amplitude) of sound and energy required to produce the sound<br>**GLE PS 4.29** Compare the rates at which sound travels through solids, liquids, and gases<br>**GLE PS 4.30** Explain the relationship between frequency (rate of vibration) and pitch | 3 | | |

(CONTINUED)

TABLE C1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 4 science and Louisiana grade 4 benchmarks and grade level expectations**

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Physical science | | | | |
| ENERGY | ***Energy transfer and conservation:*** *electrical circuits* | | | |
| **P4.11:** Electricity flowing through an electrical circuit produces magnetic effects in the wires. In an electrical circuit containing a battery, a bulb, and a bell, energy from the battery is transferred to the bulb and the bell, which in turn transfer the energy to their surroundings as light, sound, and heat (thermal energy). | **PS-E-C4** investigating and describing how electricity travels in a circuit<br>**GLE PS 4.37** Demonstrate how a complete circuit is needed for conducting electricity<br>**GLE PS 3.30** Demonstrate and explain the movement of electricity in closed and open circuits<br>**PS-E-C6** exploring and describing simple energy transformations<br>**GLE PS 4.39** Describe energy transformations (e.g., electricity to light, friction to heat)<br>**GLE PS 3.31** Compare and describe the common forms of energy and explain how they are used in everyday life (e.g., light, electricity, heat, mechanical)<br>**GLE PS 3.32** Give examples of how energy can be used to move or lift objects<br>**GLE PS 3.33** Identify simple machines and the tasks they make possible<br>**PS-M-C6** describing the types of energy that can be involved, converted, or released in electrical circuits<br>**GLE PS 5.14** Identify other types of energy produced through the use of electricity | 2 | IC<br>IC<br>MC | LEAP says "circuit" but does not specify bulb & bell<br>Missing magnetic effects from circuit until taught in High Sch.<br>LEAP says "energy converted or released" but does not say to what forms<br>Could be a "3" if, to "how electricity travels in a circuit", the words "using a light bulb, bell and coil with nail to show magnetic effects in circuits", were added |
| MOTION | ***Motion at the macroscopic level:*** *descriptions of position and motion* | | | |
| **P4.12:** An object's position can be described by locating the object relative to other objects or a background. The description of an object's motion from one observer's view may be different from that reported from a different observer's view. | **PS-E-B1** observing and describing the position of an object relative to another object or the background<br>**PS-H-E4** illustrating how frame of reference affects our ability to judge motion | 2 | MC<br>HG | LEAP covers "The description…" in High School<br>Add to "relative to another object or the background" the phrase "and comparing the object's apparent motion from different observer positions" (this would make it a "3") |

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| MOTION | **P4.13:** An object is in motion when its position is changing. The speed of an object is defined by how far it travels divided by the amount of time it took to travel that far. | **PS-E-B3** describing an object's motion by tracing and measuring its position over time<br>**GLE PS 4.26** Measure, record, and graph changes in position over time (e.g., speed of cars, ball rolling down inclined plane)<br>**GLE PS 3.25** Observe and analyze motion and position of objects over time (e.g., shadows, apparent path of the Sun across the sky | 3 | IC | LEAP benchmark doesn't say "speed" but instead says "position over time". However, GLE PS 4.26 refers to speed and graphing position and time<br>p. 3-26 Benchmark Q looks at the direction of movement—not speed but p. 3-12 in LEAP assessment guide Gr 4 does specify math to determine rate of motion, so both graphing and calculating speed are indicated.<br>use "mathematics to determine rate of motion (speed = distance divided by time)" |
| | ***Forces affecting motion:*** *the association of changes in motion with forces and the association of objects falling toward Earth with gravitational force* | | | | |
| | **P4.14:** The motion of objects can be changed by pushing or pulling. The size of the change is related to the size of the force (push or pull) and the weight (mass) of the object on which the force is exerted. When an object does not move in response to a push or a pull, it is because another push or pull (friction) is being applied by the environment. | **PS-E-B2** exploring and recognizing that the position and motion of objects can be changed by pushing or pulling (force) over time<br>**GLE PS 3.23** Demonstrate how force is a *push* or a *pull* by using students' bodies, toy cars, or balls<br>**GLE PS 3.24** Explain how the amount and direction of force exerted on an object (e.g., push, pull, friction, gravity) determine how much the object will move<br>**PS-E-B4** investigating and describing how the motion of an object is related to the strength of the force (pushing or pulling) and the mass of the object<br>**GLE PS 3.26** Explain the effect of varying amounts of force on the motion of an object | 3 | MC | "When an object…" No match found in benchmarks (missing friction) but GLEs address friction |

(CONTINUED)

TABLE C1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 4 science and Louisiana grade 4 benchmarks and grade level expectations**

| | NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| MOTION | **P4.15:** Earth pulls down on all objects with a force called gravity. With a few exceptions (helium filled balloons), objects fall to the ground no matter where the object is on Earth. | **PS-E-C5** investigating and communicating that magnetism and gravity can exert forces on objects without touching the objects<br>**GLE PS 4.38** Explain the effects of Earth's gravity on all objects at or near the surface of Earth<br>**GLE PS 5.8** Explain that gravity accelerates all falling objects at the same rate in the absence of air resistance | 3 | IC | LEAP benchmark says "gravity can exert forces" but does not explain the effect of gravity, however, GLEs address this. |
| Life science | | | | | |
| STRUCTURES AND FUNCTIONS OF LIVING SYSTEMS | ***Organization and development:*** *basic needs of organisms* | | | | |
| | **L4.1:** Organisms need food, water, and air; a way to dispose of waste; and an environment in which they can live. | **LS-E-A1** identifying the needs of plants and animals, based on age-appropriate recorded observations<br>**GLE LS 3.34** Describe what the human body needs to grow and be healthy<br>**LS-E-C1** examining the habitats of plants and animals and determining how basic needs are met within each habitat<br>**GLE LS 4.50** Explain how some organisms in a given habitat compete for the same resources<br>**GLE LS 4.51** Describe how organisms can modify their environment to meet their needs (e.g., beavers making dams) | 2 | IC | LEAP benchmark only says "needs of plants & animals" and even with GLEs, these "needs" still need to be clarified (i.e., waste disposal, etc.)<br>LEAP benchmark uses "habitat" vs. "environment"<br>This could be a "3" if it specified the needs of organisms (food, water, air, way to dispose of waste) |
| | ***Matter and energy transformations:*** *the basic needs of organisms for growth* | | | | |
| | **L4.2:** Organisms have basic needs. Animals require air, water, and a source of energy and building material for growth and repair. Plants also require light. | **LS-E-A1** identifying the needs of plants and animals, based on age-appropriate recorded observations<br>**GLE LS 4.40** Explain the functions of plant structures in relation to their ability to make food through photosynthesis (e.g., roots, leaves, stems, flowers, seeds)<br>**GLE LS K.21** Distinguish food items from nonfood items of organisms<br>**GLE LS 3.35** Compare structures (parts of the body) in a variety of animals (e.g., fish, mammals, reptiles, amphibians, birds, insects)<br>**GLE LS 3.36** Compare structures (e.g., roots, leaves, stems, flowers, seeds) and their functions in a variety of plants<br>**GLE LS 3.37** Describe how plant structures enable the plant to meet its basic needs | 2 | IC | LEAP is vague, using only the word "needs" not listing the needs. "Needs" should be clarified (such as source of energy and building material).<br>GLE LS 4.40 - light is implied<br>This could be a "3" if it specifed the needs of organisms (source of energy, material for growth and repair, water, air, way to dispose of waste) |

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Life science | | | | |
| STRUCTURES AND FUNCTIONS OF LIVING SYSTEMS | ***Interdependence:*** *the interdependence of organisms* | | | |
| **L4.3:** Organisms interact and are interdependent in various ways including providing food and shelter to one another. Organisms can survive only in environments in which their needs are met. Some interactions are beneficial; others are detrimental to the organism and other organisms. | **LS-E-C3** observing animals and plants and describing interaction or interdependence<br>**GLE LS 4.41** Describe how parts of animals' bodies are related to their functions and survival (e.g., wings/flying, webbed feet/swimming)<br>**GLE LS 4.54** Describe the effect of sudden increases or decreases of one group of organisms upon other organisms in the environment<br>**SE-E-A1** understanding that an ecosystem is made of living and non-living components<br>**GLE LS 4.70** Design an ecosystem that includes *living (biotic)* and *nonliving (abiotic)* components and illustrates interdependence<br>**SE-E-A2** understanding the components of a food chain<br>**GLE SE 4.71** Describe and explain food chains/webs and the directional flow of energy in various ecosystems (e.g., construct a model, drawing, diagram, graphic organizer)<br>**SE-E-A3** identifying ways in which humans have altered their environment both in positive and negative ways, either for themselves or for other living things<br>**GLE SE 3.57** Describe the interrelationships of *living (biotic)* and *nonliving (abiotic)* components within various ecosystems<br>**GLE SE 3.58** Describe how humans have had negative and positive effects on organisms and their environments<br>**LS-E-C1** examining the habitats of plants and animals and determining how basic needs are met within each habitat<br>**GLE LS 4.50** Explain how some organisms in a given habitat compete for the same resources<br>**GLE LS 4.51** Describe how organisms can modify their environment to meet their needs (e.g., beavers making dams) | 3 | MC | LS-E-C1 says "how needs are met" but does not specify food & shelter<br>SE-E-A2 - food chains tend to focus on who eats whom, not how, for example, a tree provides nest space<br>LS-E-C2 says "specific habitat" which implies that the "needs are met"<br>However, it appears that GLE LS 4.70 addresses the concerns above. |

(CONTINUED)

TABLE C1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 4 science and Louisiana grade 4 benchmarks and grade level expectations**

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Life science | | | | | |
| STRUCTURES AND FUNCTIONS OF LIVING SYSTEMS | **L4.3 (continued)** | **GLE LS 4.52** Describe how some plants and animals have adapted to their habitats<br>**GLE LS 4.53** Identify the habitat in which selected organisms would most likely live and explain how specific structures help organisms to survive | 3 | MC | (see page 35) |
| | **L4.4:** When the environment changes, some plants and animals survive and reproduce; others die or move to new locations. | **LS-E-C2** describing how the features of some plants and animals enable them to live in specific habitats<br>**GLE LS 4.52** Describe how some plants and animals have adapted to their habitats<br>**GLE LS 4.53** Identify the habitat in which selected organisms would most likely live and explain how specific structures help organisms to survive<br>**SE-E-A2** understanding the components of a food chain<br>**GLE SE 4.72** Predict and describe consequences of the removal of one component in a balanced ecosystem (e.g., consumer, herbivores, nonliving component)<br>**SE-E-A3** identifying ways in which humans have altered their environment both in positive and negative ways, either for themselves or for other living things<br>**GLE SE 3.58** Describe how humans have had negative and positive effects on organisms and their environments<br>**SE-E-A5** understanding that most plant and animal species are threatened or endangered today due to habitat loss or change<br>**GLE ESS 3.61** Explain how selected animals once classified as endangered have recovered<br>**GLE ESS 3.62** Identify animals in Louisiana that have recovered and that are no longer considered endangered<br>**GLE ESS 3.58** Describe how humans have had negative and positive effects on organisms and their environments<br>**LS-M-D2** explaining how some members of a species survive under changed environmental conditions | 3 | IC | LS-M-D2 does not include "die or move", only how members "survive" ", but states 'endangered' in SE-E-A5<br>Also, GLE SE 4.72 clarifies removal which could be die or move |

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Life science | | | | |
| CHANGES IN LIVING SYSTEMS | ***Heredity and reproduction:*** *life cycles* | | | |
| **L4.5:** Plants and animals have life cycles. Both plants and animals begin life and develop into adults, reproduce, and eventually die. The details of this life cycle are different for different organisms. | **LS-E-B1** observing and describing the life cycles of some plants and animals<br>**GLE LS 4.46** Describe how some plants can be grown from a plant part instead of a seed<br>**GLE LS 4.47** Sequence stages in the life cycles of various organisms, including seed plants<br>**GLE LS 4.45** Identify reproductive structures in plants and describe the functions of each<br>**GLE LS 3.33** Compare the life cycles of selected organisms<br>**LS-E-B2** observing, comparing, and grouping plants and animals according to likenesses and/or differences<br>**GLE LS 4.48** Classify examples of plants and animals based on a variety of criteria | 3 | IC | LEAP says "life cycle" but does not specify "adults, reproduce… die"<br>LEAP says "comparing… differences"<br>GLE LS 4.47 should say sequence AND COMPARE with other life cycles |
| **L4.6:** Plants and animals closely resemble their parents. | **LS-E-B2** observing, comparing, and grouping plants and animals according to likenesses and/or differences<br>**GLE LS 4.48** Classify examples of plants and animals based on a variety of criteria<br>**LS-E-B3** observing and recording how the offspring of plants and animals are similar to their parents<br>**GLE LS 4.49** Compare similarities and differences between parents and offspring in plants and animals | 3 | | |

(CONTINUED)

TABLE C1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 4 science and Louisiana grade 4 benchmarks and grade level expectations**

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Life science | | | | |
| **CHANGES IN LIVING SYSTEMS** | ***Evolution and diversity:*** *differences and adaptations of organisms* | | | |
| **L4.7:** Different kinds of organisms have characteristics that enable them to survive in different environments. Individuals of the same kind differ in their characteristics, and sometimes the differences give individuals an advantage in surviving and reproducing. | **LS-E-C2** describing how the features of some plants and animals enable them to live in specific habitats<br>**GLE LS 4.52** Describe how some plants and animals have adapted to their habitats<br>**GLE LS 4.53** Identify the habitat in which selected organisms would most likely live and explain how specific structures help organisms to survive<br>**LS-E-A4** recognizing that there is great diversity among organisms<br>**GLE LS 3.38** Classify groups of organisms based on common characteristics<br>**GLE LS 3.39** Compare organisms from different groups (e.g., birds with mammals, terrestrial plants with aquatic plants)<br>**LS-M-D2** explaining how some members of a species survive under changed environmental conditions<br>**GLE LS 7.32** Describe changes that can occur in various ecosystems and relate the changes to the ability of an organism to survive | 2 | MC<br>HG | LS-E-C2 only says some members may live (or survive) but does not point out how specific members in a species may have traits which enable them to survive<br>LS-E-A4 - "Great diversity" is comparing between species not within species<br>This could be a "3" if, to "great diversity among organisms", the concept "and also variety within members of the same species which may allow some members to survive or reproduce, and others not" was added. |

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Earth and space science | | | | |
| EARTH IN SPACE AND TIME | ***Objects in the universe:*** *patterns in the sky* | | | |
| **E4.1:** Objects in the sky have patterns of movement. The sun, for example, appears to move across the sky in the same way every day, but its path changes slowly over the seasons. The moon appears to move across the sky on a daily basis much like the sun. | **ESS-E-B1** observing and describing the characteristics of objects in the sky<br>**GLE ESS 3.53** Identify, in order, the planets of the solar system<br>**ESS-E-B4** modeling changes that occur because of the rotation of Earth (alternation of night and day) and the revolution of Earth around the Sun<br>**GLE ESS 4.68** Identify the relationship between Earth's tilt and revolution and the seasons<br>**GLE ESS 3.55** Explain the results of the rotation and revolution of Earth (e.g., day and night, year)<br>**GLE ESS 3.56** Compare shadow direction and length at different times of day and year<br>**ESS-E-B3** observing and recording the changing appearances and positions of the Moon in the sky at night and determining the monthly pattern of lunar change<br>**GLE ESS 4.67** Explain the changing appearance of the Moon and its location in the sky over the course of a month | 3 | IC | LEAP says "rotation" & "revolution"<br>See p. 3-32 LA Oct 06 Benchmark test Q. |
| **E4.2:** The observable shape of the moon changes from day to day in a cycle that lasts about a month. | **ESS-E-B2** demonstrating how the relationship of Earth, the Moon, and the Sun causes eclipses and moon phases<br>**GLE ESS 4.64** Describe and sequence the phases of the Moon and eclipses<br>**GLE ESS 4.65** Compare a solar and a lunar eclipse<br>**GLE ESS 4.66** Diagram the movement of the Moon around Earth and the movement of Earth around the Sun<br>**GLE ESS 3.54** Describe the patterns of apparent change in the position of the Sun<br>**ESS-E-B3** observing and recording the changing appearances and positions of the Moon in the sky at night and determining the monthly pattern of lunar change<br>**GLE ESS 4.67** Explain the changing appearance of the Moon and its location in the sky over the course of a month | 3 | | Louisiana is more detailed than NAEP. |

(CONTINUED)

TABLE C1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 4 science and Louisiana grade 4 benchmarks and grade level expectations**

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Earth and space science | | | | |
| **EARTH IN SPACE AND TIME** | ***History of Earth:*** *evidence of change* | | | |
| **E4.3:** The surface of Earth changes. Some changes are due to slow processes, such as erosion and weathering, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes. | **GLE ESS 4.55** Recognize that sedimentary rocks are composed of particles that result from weathering and erosion (e.g., sandstones, conglomerates)<br>**GLE ESS 4.63** Demonstrate and explain how Earth's surface is changed as a result of slow and rapid processes (e.g., sand dunes, canyons, volcanoes, earthquakes)<br>**ESS-M-B3** understanding that the Earth processes, such as erosion and weathering, that affect Earth today are similar to those which occurred in the past<br>**GLE ESS 5.38** Estimate the range of time over which natural events occur (e.g., lightning in seconds, mountain formation over millions of years<br>**ESS-M-A3** investigating the characteristics of earthquakes and volcanoes and identifying zones where they may occur<br>**ESS-M-A7** modeling how landforms result from the interaction of constructive and destructive forces<br>**GLE ESS 5.32** Demonstrate the results of constructive and destructive forces using models or illustrations<br>**GLE ESS 5.33** Identify the processes that prevent or cause erosion | 3 | | GLE ESS 4.55 and GLE ESS 4.63 apply to ESS-E-A1, but the benchmark does not apply to NAEP E4.3 Landslides are implied but not mentioned specifically—but it is a type of erosion |

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Earth and space science | | | | |
| EARTH STRUCTURES | ***Properties of Earth materials:*** *natural and human-made materials* | | | |
| **E4.4:** Earth materials that occur in nature include rocks, minerals, soils, water, and the gases of the atmosphere. | **ESS-E-A1** understanding that earth materials are rocks, minerals, and soils<br>**GLE ESS 4.56** Investigate the properties of soil (e.g., color, texture, capacity to retain water, ability to support plant growth)<br>**GLE ESS 4.55** Recognize that sedimentary rocks are composed of particles that result from weathering and erosion (e.g., sandstones, conglomerates)<br>**GLE ESS 3.45** Recognize and describe that rock is composed of different combinations of minerals<br>**GLE ESS 3.46** Describe earth processes that have affected selected physical features in students' neighborhoods (e.g., rusting, weathering, erosion)<br>**GLE ESS 3.51** Identify and compare the components found in soil<br>**ESS-E-A3** investigating, observing, and describing how water changes from one form to another and interacts with the atmosphere<br>**GLE ESS 4.58** Draw, label, and explain the components of a water cycle<br>**GLE ES 5.35** Identify the atmosphere as a mixture of gases, water vapor, and particulate matter<br>**GLE 3.48** Identify examples of the processes of a water cycle (e.g., evaporation, condensation, precipitation, collection of runoff) | 3 | IC | ESS-E-A1 is missing "gases"<br>ESS-E-A3 only mentions water in the atmosphere but not gases<br>However, these are addressed by the GLEs. |

(CONTINUED)

TABLE C1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 4 science and Louisiana grade 4 benchmarks and grade level expectations**

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Earth and space science | | | | | |
| EARTH STRUCTURES | **E4.5:** Natural materials have different properties, which sustain plant and animal life. | **SE-E-A4** understanding that the original sources of all material goods are natural resources and that the conserving and recycling of natural resources is a form of stewardship<br>**GLE ESS.3.59** Classify manufactured products according to the natural resources from which they are made<br>**GLE ESS 3.60** Explain how renewable and nonrenewable resources can be replenished or depleted<br>**SE-E-A1** understanding that an ecosystem is made of living and non-living components<br>**GLE ES 1.39** Identify the characteristics of soil, according to color, texture, and components, including *living (biotic)* and *nonliving (abiotic)* substances<br>**GLE SE 4.70** Design an ecosystem that includes *living (biotic)* and *nonliving (abiotic)* components and illustrates interdependence<br>**GLE SE 3**.57 Describe the interrelationships of *living (biotic)* and *nonliving (abiotic)* components within various ecosystems<br>**ESS-M-A5** identifying the characteristics and uses of minerals and rocks and recognizing that rocks are mixtures of minerals<br>**GLE ES.5.31** Identify common rocks and minerals and explain their uses and economic significance | 2 | IC | ESS-M-A5 says "characteristics and uses of minerals"<br>SE-E-A4 "natural resources"<br>SE-E-A1 "nonliving components"<br>Louisiana needs to specify all of the non-living components and how they are used by different types of organisms |
| | **E4.6:** Some Earth materials have properties that make them useful either in their present form or designed and modified to solve human problems and enhance the quality of life, as in the case of materials used for building or fuels used for heating and transportation. | **SE-E-A4** understanding that the original sources of all material goods are natural resources and that the conserving and recycling of natural resources is a form of stewardship<br>**GLE ESS 3.59** Classify manufactured products according to the natural resources from which they are made<br>**GLE ESS 3.60** Explain how renewable and nonrenewable resources can be replenished or depleted<br>**PS-M-C8** comparing the uses of different energy resources and their effects upon the environment | 2 | MC | SE-E-A4 says "natural resources" but is not specific about human uses |

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Earth and space science | | | | |
| EARTH SYSTEMS | ***Energy in Earth systems:*** *role of the sun* | | | |
| **E4.7:** The sun warms the land, air, and water and helps plants grow. | **GLE LS 4.40** Explain the functions of plant structures in relation to their ability to make food through photosynthesis (e.g., roots, leaves, stems, flowers, seeds)<br>**ESS-E-A3** investigating, observing, and describing how water changes from one form to another and interacts with the atmosphere<br>**GLE ESS 4.58** Draw, label, and explain the components of a water cycle<br>**GLE ESS 3.48** Identify examples of the processes of a water cycle (e.g., evaporation, condensation, precipitation, collection of runoff<br>**ESS-E-B5** understanding that the Sun, a star, is a source of heat and light energy and identifying its effects upon Earth<br>**ESS-E-A2** understanding that approximately three-fourths of Earth's surface is covered with water and how this condition affects weather patterns and climates<br>**GLE ESS 4.57** Explain how unequal heating of Earth's land and water affects climate and weather by using a model<br>**GLE ESS 3.47** Describe the difference between weather and climate | 3 | IC | ESS-E-A3 water cycle<br>ESS-E-B5 "Sun…heat & light…effects upon earth"<br>No benchmark match to "help plants grow" but GLE LS 4.40 mentions plant structure & photosynthesis |

(CONTINUED)

TABLE C1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 4 science and Louisiana grade 4 benchmarks and grade level expectations**

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Earth and space science | | | | |
| EARTH SYSTEMS | ***Climate and weather:*** *local weather* | | | |
| **E4.8:** Weather changes from day to day and over the seasons. | **ESS-E-A2** understanding that approximately three-fourths of Earth's surface is covered with water and how this condition affects weather patterns and climates<br>**GLE ESS 4.57** Explain how unequal heating of Earth's land and water affects climate and weather by using a model<br>**GLE ESS 3.47** Describe the difference between weather and climate<br>**ESS-E-A4** investigating, observing, measuring, and describing changes in daily weather patterns and phenomena<br>**GLE ESS 4.59** Measure, chart, and predict the weather using various instruments (e.g., thermometer, barometer, anemometer)<br>**ESS-E-B4** modeling changes that occur because of the rotation of Earth (alternation of night and day) and the revolution of Earth around the Sun<br>**GLE ESS 4.68** Identify the relationship between Earth's tilt and revolution and the seasons<br>**GLE ESS 3.49** Describe climate patterns from recorded weather conditions over a period of time<br>**GLE ESS 3.55** Explain the results of the rotation and revolution of Earth (e.g., day and night, year)<br>**GLE ESS 3.56** Compare shadow direction and length at different times of day and year<br>**ESS-M-A12** predicting weather patterns through use of a weather map<br>**GLE ESS 5.37** Identify typical weather map symbols and the type of weather they represent | 3 | IC | Benchmarks are vague (weather patterns & climate) but GLEs match the NAEP standard. |

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Earth and space science | | | | | |
| EARTH SYSTEMS | **E4.9:** Scientists use tools for observing, recording, and predicting weather changes from day to day and over the seasons. | **ESS-E-A4** investigating, observing, measuring, and describing changes in daily weather patterns and phenomena<br>**GLE ESS 4.59** Measure, chart, and predict the weather using various instruments (e.g., thermometer, barometer, anemometer)<br>**GLE ESS 4.60** Identify various types of weather-related natural hazards and effects (e.g., lightning, storms)<br>**GLE ESS 4.61** Identify safety measures applicable to natural hazards<br>**GLE** ESS 3.49 Describe climate patterns from recorded weather conditions over a period of time | 3 | IC | ESS-E-A4 does not reference tools but GLE ESS 4.59 defines weather tools |
| | ***Biogeochemical cycles:*** *uses of Earth resources* | | | | |
| | **E4.10:** The supply of many Earth resources such as fuels, metals, fresh water, and farmland is limited. Humans have devised methods for extending the use of Earth resources through recycling, reuse, and renewal. | **SE-E-A4** understanding that the original sources of all material goods are natural resources and that the conserving and recycling of natural resources is a form of stewardship<br>**GLE PS 6.46** Identify ways people can reuse, recycle, and reduce the use of resources to improve and protect the quality of life<br>**GLE LS 7.35** Identify resources humans derive from ecosystems<br>**GLE ES 3.60** Explain how renewable and nonrenewable resources can be replenished or depleted<br>**GLE ESS.3.59** Classify manufactured products according to the natural resources from which they are made | 2 | IC | Louisiana does not specify resources |

(CONTINUED)

TABLE C1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 4 science and Louisiana grade 4 benchmarks and grade level expectations**

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Earth and space science | | | | | |
| EARTH SYSTEMS | **E4.11:** Humans depend on their natural and constructed environment. Humans change environments in ways that can either be beneficial or detrimental for themselves and other organisms. | **SE-E-A3** identifying ways in which humans have altered their environment, both in positive and negative ways, either for themselves or for other living things<br>**GLE SE 3.58** Describe how humans have had negative and positive effects on organisms and their environments<br>**SE-E-A4** understanding that the original sources of all material goods are natural resources and that the conserving and recycling of natural resources is a form of stewardship<br>**GLE ESS 3.59** Classify manufactured products according to the natural resources from which they are made<br>**GLE ESS 3.60** Explain how renewable and nonrenewable resources can be replenished or depleted<br>**(SE-E-A5)** understanding that most plant and animal species are threatened or endangered today due to habitat loss or change<br>**GLE ESS 3.61** Explain how selected animals once classified as endangered have recovered<br>**GLE ESS 3.62** Identify animals in Louisiana that have recovered and that are no longer considered endangered<br>**GLE ESS 3.58** Describe how humans have had negative and positive effects on organisms and their environments | 3 | | |

a. Rating is based on a scale of 1 to 3, where 1 indicates that state standards do not address NAEP content statement, 2 that state standards partially address NAEP content statement, and 3 that state standards fully address or exceed NAEP content statement by targeted grade level.

b. Codes are IC (implied content), LG (content covered at a lower grade level), HG (content covered at a higher grade level), MC (more content), and MD (more detailed content). See appendix C for further information.

TABLE C2

**Louisiana grade 4 standards not covered by National Assessment of Educational Progress grade 4 content**

| Content area | Louisiana grade 4 standards |
|---|---|
| Science as inquiry | SI-E-A1, SI-E-A2, SI-E-A3, SI-E-A4, SI-E-A5, SI-E-A6, SI-E-A7<br>SI-E-B1, SI-E-B2, SI-E-B3, SI-E-B4, SI-E-B5, SI-E-B6 |
| Physical science | All Physical Science standards in NAEP are reflected in LA standards although LA content is often implied, and in several standards, LA is actually more specific |
| Life science | LS-E-A2, , LS-E-A5, LS-E-A6, LS-E-B4 |
| Earth and space science | ESS-E-A2 partial (3/4's surface water not in NAEP), ESS-E-A5, ESS-E-A6, ESS-E-A7, ESS-E-B6 |
| Science and the environment | All LA Science and the Environment standards are addressed, although minimally in NAEP |

# APPENDIX D
# CONTENT ALIGNMENT FOR GRADE 8

TABLE D1

**Alignment of National Assessment of Educational Progress grade 8 science and Louisiana grade 8 benchmarks and grade level expectations**

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Physical science | | | | |
| MATTER | ***Properties of matter:*** *chemical properties, particulate nature of matter, and the Periodic Table of Elements* | | | |
| **P8.1:** Properties of solids, liquids, and gases are explained by a model of matter that is composed of tiny particles in motion. | **PS-M-A4** understanding that atoms and molecules are perpetually in motion<br>**GLE-6.6** Draw or model the movement of atoms in solid, liquid, and gaseous states<br>**GLE-6.7** Simulate how atoms and molecules have kinetic energy exhibited by constant motion<br>**GLE-6.8** Determine the temperatures at which water changes physical phases (e.g., freezing point, melting point, boiling point) | 3 | | |
| **P8.2:** Chemical properties of substances are explained by the arrangement of atoms and molecules. | | 1 | | |
| **P8.3:** All substances are composed of one or more of approximately one hundred elements. The Periodic Table organizes the elements into families of elements with similar properties. | **PS-M-A3** grouping substances according to similar proper-ties and/or behaviors | 2 | MD/IC | Does not refer to the fact that all substances composed of the elements in the PToE |
| **P8.4:** Elements are a class of substances composed of a single kind of atom. Compounds are composed of two or more different elements. Each element and compound has physical and chemical properties, such as boiling point, density, color, and conductivity, which are independent of the amount of the sample. | **PS-M-A2** understanding that all matter is made up of particles called atoms and that atoms of different elements are different<br>**PS-M-A1** investigating, measuring, and communicating the properties of different substances which are independent of the amount of the substance<br>**GLE-8.1** Determine that all atoms of the same element are similar to but different from atoms of other elements | 2 | MD/IC | |

TABLE D1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 8 science and Louisiana grade 8 benchmarks and grade level expectations**

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| MATTER | **P8.5:** Substances are classified according to their physical and chemical properties. Metals and acids are examples of such classes. Metals are a class of elements that exhibit common physical properties such as conductivity and common chemical properties such as reacting with nonmetals to produce salts. Acids are a class of compounds that exhibit common chemical properties including a sour taste, characteristic color changes with litmus and other acid/base indicators, and the tendency to react with bases to produce a salt and water. | **PS-M-A3** grouping substances according to similar proper-ties and/or behaviors<br>**GLE-6.4** Differentiate between the physical and chemical properties of selected substances | 2 | MD/IC | State says " similar properties"; standard does not break down properties to physical and chemical and does not provide examples. |
| | ***Changes in matter:*** *physical and chemical changes and conservation of mass* | | | | |
| | **P8.6:** Changes of state are explained by a model of matter composed of tiny particles that are in motion. When substances undergo changes of state, neither atoms nor molecules themselves are changed in structure. Mass is conserved when substances undergo changes of state. | **PS-M-A4** understanding that atoms and molecules are perpetually in motion<br>**PS-M-A5** investigating the relationships among temperature, molecular motion, phase changes, and physical properties of matter<br>**GLE-6.5** Compare physical and chemical changes<br>**GLE-6.6** Draw or model the movement of atoms in solid, liquid, and gaseous states | 2 | IC | |
| | **P8.7:** *Chemical changes can occur when two substances, elements, or compounds react and produce one or more different substances, whose physical and chemical properties are different from the reacting substances. **When substances undergo chemical change, the number and kinds of atoms in the reactants are the same as the number and kinds of atoms in the products. Mass is conserved when substances undergo chemical change. The mass of the reactants is the same as the mass of the products. | ***PS-M-A6** investigating chemical reactions between different substances to discover that new substances formed may have new physical properties and do have new chemical properties<br>****PS-M-A7** understanding that during a chemical reaction in a closed system, the mass of the products is equal to that of the reactants<br>**GLE-6.9** Describe the properties of reactants and products of chemical reactions observed in the lab<br>**GLE-6.11** Compare the masses of reactants and products of a chemical reaction | 2 | MD | *Chemical changes change properties.<br>** Conservation of Mass |

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| ENERGY | ***Forms of energy*:** *kinetic energy, potential energy, and light energy from the sun* | | | | |
| | **P8.8:** Objects and substances in motion have kinetic energy. For example, a moving baseball can break a window; water flowing down a stream moves pebbles and floating objects along with it. | **PS-M-C1** identifying and comparing the characteristics of different types of energy<br>**GLE-5.3** Describe the structure of atoms and the electrical charge of protons, neutrons, and electrons | 2 | IC | State says "energy types" does not specify as kinetic |
| | **P8.9:** Three forms of potential energy are gravitational, elastic, and chemical. Gravitational potential energy changes in a system as the relative positions of objects are changed. Objects can have elastic potential energy due to their compression, or chemical potential energy due to the nature and arrangement of the atoms. | **PS-M-C1** identifying and comparing the characteristics of different types of energy<br>**GLE-6.24** Describe and give examples of how all forms of energy may be classified as potential or kinetic energy | 2 | IC | State says "energy types" does not specify as potential |
| | **P8.10:** *Energy is transferred from place to place. **Light energy from the sun travels through space to Earth (radiation). Thermal energy travels from a flame through the metal of a cooking pan to the water in the pan (conduction). Air warmed by a fireplace moves around a room (convection). ***Waves—including sound and seismic waves, waves on water, and light waves—****have energy and transfer energy when they interact with matter. | ****PS-M-C1** identifying and comparing the characteristics of different types of energy<br>*****PS-M-C5** investigating and describing the movement of heat and the effects of heat in objects and systems<br>**GLE-6.37** Compare how heat is transferred by conduction, convection, and radiation | 2 | IC<br>MD | *Energy transfer<br>** Sun named as major source<br>***does not specify method of heat transfer but "movement of heat and the effects of heat in objects and systems".<br>**** only addresses "light waves interact with matter" does not mention other waves. |
| | **P8.11:** *A tiny fraction of the light energy from the sun reaches Earth. **Light energy from the sun is Earth's primary source of energy, heating Earth surfaces ***and providing the energy that results in wind, ocean currents, and storms. | *<br>****PS-M-C3** understanding that the Sun is a major source of energy and that energy arrives at Earth's surface as light with a range of wavelengths<br>*****ESS-M-C6** modeling and describing how radiant energy from the Sun affects phenomena on the Earth's surface, such as winds, ocean currents, and the water cycle | 2 | IC<br>MD | *Not specified in state standard<br>** &*** addressed in two state standards |

(CONTINUED)

TABLE D1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 8 science and Louisiana grade 8 benchmarks and grade level expectations**

| | NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| ENERGY | ***Energy transfer and conservation:*** *energy transfer and conservation of energy* | | | | |
| | **P8.12:** *When energy is transferred from one system to another, the quantity of energy before transfer equals the quantity of energy after transfer. For example, as an object falls, its potential energy decreases as its speed, and consequently, its kinetic energy increases. ***While an object is falling, some of the object's kinetic energy is transferred to the medium through which it falls, setting the medium into motion and heating it. | ***PS-M-C2** understanding the different kinds of energy transformations and the fact that energy can be neither destroyed nor created<br>**GLE-6.28** Explain the law of conservation of energy<br>**GLE-6.38** Identify conditions under which thermal energy tends to flow from a system of higher energy to a system of lower energy | 2 | MC<br>MD | *** not addressed by state standard |
| | **P8.13:** Nuclear reactions take place in the sun. In plants, light from the sun is transferre3d to oxygen and carbon compounds, which, in combination, have chemical potential energy (photosynthesis). | | 1 | | |
| MOTION | ***Motion at the macroscopic level*:** *speed as a quantitative description of motion and graphical representations of speed* | | | | |
| | **P8.14:** An object's motion can be described by its speed and the direction in which it is moving. An object's position can be measured and graphed as a function of time. An object's speed can be measured and graphed as a function of time. | **PS-M-B1** describing and graphing the motions of objects<br>**GLE-6.16** Compare line graphs of acceleration, constant speed, and deceleration | 2 | MD/<br>IC | Does not reference the vector model of motion or that motion can be represented in graphical form. |
| | ***Forces affecting motion:*** *qualitative descriptions of magnitude and direction as characteristics of forces, addition of forces, contact forces, forces that act at a distance, and net force on an object and its relationship to the object's motion* | | | | |
| | **P8.15:** Some forces between objects act when the objects are in direct contact or when they are not touching. Magnetic, electrical, and gravitational forces can act at a distance. | **PS-M-B2** recognizing different forces and describing their effects (gravity, electrical, magnetic)<br>**GLE-6.17** Describe and demonstrate that friction is a force that acts whenever two surfaces or objects move past one another<br>**GLE-6.19** Identify forces acting on all objects | 2 | MD/<br>IC | Does not address the proximity component of the NAEP standard. |

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| **Physical science** | | | | |
| **MOTION** | | | | |
| **P8.16:** Forces have magnitude and direction. Forces can be added. The net force on an object is the sum of all the forces acting on the object. A nonzero net force on an object changes the object's motion; that is, the object's speed and/or direction of motion changes. A net force of zero on an object does not change the object's motion; that is, the object remains at rest or continues to move at a constant speed in a straight line. | **PS-M-B4** describing how forces acting on an object will reinforce or cancel one another, depending upon their direction and magnitude<br>**GLE-6.15** Explain why velocity is expressed in both speed and direction<br>**GLE-6.21** Determine the magnitude and direction of unbalanced (i.e., net) forces acting on an object<br>**GLE-6.22** Demonstrate that an object will remain at rest or move at a constant speed and in a straight line if it is not subjected to an unbalanced force<br>**GLE-6.23** Predict the direction of a force applied to an object and how it will change the speed and direction of the object | 3 | | |
| **Life science** | | | | |
| **STRUCTURES AND FUNCTIONS OF LIVING SYSTEMS** | ***Organization and development: basic needs of organisms:*** *the levels of organization of living systems* | | | |
| **L8.1:** All organisms are composed of cells, from just one cell to many cells. About two-thirds of the weight of cells is accounted for by water, which gives cells many of their properties. In multicellular organisms, specialized cells perform specialized functions. Organs and organ systems are composed of cells and function to serve the needs of cells for food, air, and waste removal. The way in which cells function is similar in all living organisms. | **GLE-5.15** Identify the cell as the basic unit of living things<br>**GLE-5.16** Observe, identify, and describe the basic components of cells and their functions (e.g., cell wall, cell membrane, cytoplasm, nucleus)<br>**GLE-7.2** Compare the basic structures and functions of different types of cells | 2 | MD | |
| **L8.2:** Following fertilization, cell division produces a small cluster of cells that then differentiate by appearance and function to form the basic tissues of an embryo. | **LS-M-B1** describing the importance of body cell division (mitosis) and sex cell production (meiosis) | 2 | IC | LA standard does not mention embryo or differentiation |
| | ***Matter and energy transformations:*** *the role of carbon compounds in growth and metabolism* | | | |
| **L8.3:** *Cells carry out the many functions needed to sustain life. **They grow and divide, thereby producing more cells. ***Food is used to provide energy for the work that cells do and is a source of the molecular building blocks from which needed materials are assembled. | ***LS-M-A2** comparing and contrasting the basic structures and functions of different plant and animal cells<br>****LS-M-B1** describing the importance of body cell division (mitosis) and sex cell production (meiosis)<br>*** | 2 | MD<br>IC | *<br>** mitosis<br>***not addressed |

(CONTINUED)

TABLE D1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 8 science and Louisiana grade 8 benchmarks and grade level expectations**

| | NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Life science | | | | | |
| STRUCTURES AND FUNCTIONS OF LIVING SYSTEMS | **L8.4:** Plants are producers—they use the energy from light to make sugar molecules from the atoms of carbon dioxide and water. Plants use these sugars along with minerals from the soil to form fats, proteins, and carbohydrates. These products can be used immediately, incorporated into the plant's cells as the plant grows, or stored for later use. | **LS-M-A4** describing the basic processes of photosynthesis and respiration and their importance to life<br>**GLE-5.19** Describe the processes of photosynthesis and respiration in green plants | 2 | MD/ IC | Louisiana states, "describing the basic processes of photosynthesis" while NAEP gives further detail of the process |
| | **L8.5:** All animals, including humans, are consumers that meet their energy needs by eating other organisms or their products. Consumers break down the structures of the organisms they eat to make the materials they need to grow and function. Decomposers, including bacteria and fungi, use dead organisms or their products to meet their energy needs. | **SE-M-A5** tracing the flow of energy through an ecosystem and demonstrating a knowledge of the roles of producers, consumers, and decomposers in the ecosystem<br>**GLE-5.24** Describe the roles of producers, consumers, and decomposers in a food chain<br>**GLE-7.24** Analyze food webs to determine energy transfer among organisms | 2 | MD/ IC | Louisiana states, "demonstrating knowledge of the roles of producers, consumers and decomposers in the ecosystem" while NAEP details their functions |
| | ***Interdependence:*** *specific types of interdependence* | | | | |
| | **L8.6:** Two types of organisms may interact with one another in several ways: They may be in a producer/consumer, predator/ prey, or parasite/host relationship. Or, one organism may scavenge or decompose another. Relationships may be competitive or mutually beneficial. Some species have become so adapted to each other that neither could survive without the other. | **SE-M-A5** tracing the flow of energy through an ecosystem and demonstrating a knowledge of the roles of producers, consumers, and decomposers in the ecosystem<br>**GLE-5.28** Explain and give examples of predator/prey relationships<br>**GLE-7.27** Identify the various relationships among plants and animals (e.g., mutualistic, parasitic, producer/consumer)<br>**GLE-7.40** Construct or draw food webs for various ecosystems | 2 | MD/ IC | Louisiana states, "demonstrating knowledge of the roles of producers, consumers and decomposers in the ecosystem" while NAEP explains their roles and relationships |
| | **L8.7:** The number of organisms and populations an ecosystem can support depends on the biotic resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition. | **LS-M-C4** explaining the interaction and interdependence of nonliving and living components within ecosystems<br>**GLE-5.48** Determine the ability of an ecosystem to support a population (carrying capacity) by identifying the resources needed by that population<br>**GLE-7.29** Predict the impact changes in a species' population have on an ecosystem<br>**GLE-7.36** Distinguish the essential roles played by biotic and abiotic components in various ecosystems | 2 | MD/ IC | Does not mention the concept of holding capacity or limiting factors on a population in an environment. |

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Life science | | | | | |
| STRUCTURES AND FUNCTIONS OF LIVING SYSTEMS | **L8.8:** All organisms cause changes in the environment where they live. Some of these changes are detrimental to the organisms or other organisms, whereas others are beneficial. | **SE-M-A4** understanding that human actions can create risks and consequences in the environment<br>**LS-M-D2** explaining how some members of a species survive under changed environmental conditions<br>**GLE-5.50** Describe the consequences of several types of human activities on local ecosystems (e.g., polluting streams, regulating hunting, introducing nonnative species)<br>**GLE-6.29** Compare and/or investigate the relationships among work, power, and efficiency<br>**GLE-7.39** Analyze the consequences of human activities on ecosystems | 2 | IC | Louisiana is specific to human actions |
| CHANGES IN LIVING SYSTEMS | ***Heredity and reproduction:*** *reproduction and the influence of heredity and the environment on an offspring's characteristics* | | | | |
| | **L8.9:** Reproduction is a characteristic of all living systems**;** because no individual organism lives forever, reproduction is essential to the continuation of every species. Some organisms reproduce asexually. Other organisms reproduce sexually. | **GLE-7.14** Differentiate between sexual and asexual reproduction | 2 | | GLE does not relate reproduction to survival of species. |
| | **L8.10:** The characteristics of organisms are influenced by heredity and environment. For some characteristics, inheritance is more important; for other characteristics, interactions with the environment are more important. | **GLE-7.33** Illustrate how variations in individual organisms within a population determine the success of the population | 1 | | |

(CONTINUED)

TABLE D1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 8 science and Louisiana grade 8 benchmarks and grade level expectations**

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Life science | | | | |
| **CHANGES IN LIVING SYSTEMS** | ***Evolution and diversity:*** *preferential survival and relatedness of organisms* | | | |
| **L8.11:** Individual organisms with certain traits in particular environments are more likely than others to survive and have offspring. When an environment changes, the advantage or disadvantage of characteristics can change. Extinction of a species occurs when the environment changes and the characteristics of a species are insufficient to allow survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the Earth no longer exist. | **LS-M-D1** describing the importance of plant and animal adaptation, including local examples<br>**LS-M-D2** explaining how some members of a species survive under changed environmental conditions<br>**GLE-7.32** Describe changes that can occur in various ecosystems and relate the changes to the ability of an organism to survive<br>**GLE-7.33** Illustrate how variations in individual organisms within a population determine the success of the population<br>**GLE-7.34** Explain how environmental factors impact survival of a population | 2 | MD/ IC | LA standard mentions adaptation but not extinction. |
| **L8.12:** Similarities among organisms are found in anatomical features, which can be used to infer the degree of relatedness among organisms. In classifying organisms, biologists consider details of internal and external structures to be more important than behavior or general appearance. | **LS-M-C1** constructing and using classification systems based on the structure of organisms<br>**GLE-5.22** Develop and use a simple dichotomous key to classify common plants and animals<br>**GLE-7.23** Classify organisms based on structural characteristics, using a dichotomous key | 2 | MD | The NAEP standard uses anatomical similarities in reference to evolution. The LA standard refers to them in reference to taxonomy. |
| Earth and space science | | | | |
| **EARTH IN SPACE AND TIME** | ***Objects in the universe:*** *a model of the solar system* | | | |
| **E8.1:** In contrast to an earlier theory that Earth is the center of the universe, it is now known that the sun, an average star, is the central and largest body in the solar system. Earth is the third planet from the sun in a system that includes eight other planets and their moons, as well as smaller objects, such as asteroids and comets. | **ESS-M-C2** comparing and contrasting the celestial bodies in our solar system<br>**ESS-M-C5** modeling the position of Earth in relationship to other objects in the solar system<br>**GLE-5.12** Identify the Sun as Earth's primary energy source and give examples (e.g., photosynthesis, water cycle) to support that conclusion<br>**GLE-5.44** Explain rotation and revolution by using models or illustrations<br>**GLE-5.45** Identify Earth's position in the solar system<br>**GLE-8.42** Interpret a scale model of the solar system | 2 | | Different wording |

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Earth and space science | | | | |
| **EARTH IN SPACE AND TIME** | **E8.2:** Gravity is the force that keeps most objects in the solar system in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the moon, and eclipses. | **ESS-M-C3** investigating the force of gravity and the ways gravity governs motion in the solar system and objects on Earth<br>**ESS-M-C4** modeling the motions of the Earth-Moon-Sun system to explain day and night, a year, eclipses, moon phases, and tides<br>**GLE-8.5** Define gravity and describe the relationship among the force of gravity, the mass of objects, and the distance between objects<br>**GLE-8.6** Predict how the gravitational attraction between two masses will increase or decrease when changes are made in the masses or in the distance between the objects<br>**GLE-8.40** Identify and illustrate the relative positions of Earth, the Moon, and the Sun during eclipses and phases of the Moon | 3 | | ESS-M-C3 - "gravity"<br>ESS-M-C4 - "explains night, year…" |
| **EARTH STRUCTURES** | ***History of Earth:*** *estimating the timing and sequence of geologic events* | | | |
| | **E8.3:** Fossils provide important evidence of how life and environmental conditions have changed in a given location. | **ESS-M-B1** investigating how fossils show the development of life over time | 2 | MD/IC | Louisiana only addresses "development of life" not the environment |
| | **E8.4:** Earth processes seen today, such as erosion and mountain building, made possible the measurement of geologic time through methods such as observing rock sequences and using fossils to correlate the sequences at various locations. | **GLE-5.38** Estimate the range of time over which natural events occur (e.g., lightning in seconds, mountain formation over millions of years)<br>**GLE-8.31** Compare fossils from different geologic eras and areas of Earth to show that life changes over time<br>**GLE-8.33** Use historical data to draw conclusions about the age of Earth (e.g., half-life, rock strata)<br>**GLE-8.34** Apply geological principles to determine the relative ages of rock layers (e.g., original horizontality, superposition, cross-cutting relationships)<br>**GLE-8.35** Describe how processes seen today are similar to those in the past (e.g., weathering, erosion, lithospheric plate movement) | 3 | | (ESS-M-B3 has some similar wording but does not address NAEP) |

(CONTINUED)

TABLE D1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 8 science and Louisiana grade 8 benchmarks and grade level expectations**

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Earth and space science | | | | |
| EARTH STRUCTURES | ***Properties of Earth materials:*** *soil analysis and layers of the atmosphere* | | | |
| **E8.5:** Rocks and rock formations bear evidence of the minerals, materials, temperature/pressure conditions, and forces that created them. Some formations show evidence that they were deposited by volcanic eruptions. Others are composed of sand and smaller particles buried and cemented by dissolved minerals to form solid rock again. Still others show evidence that they were once earlier rock types that were exposed to heat and pressure until they changed shape and in some cases melted and recrystallized. | **ESS-M-A6** explaining the processes involved in the rock cycle<br>**ESS-M-A5** identifying the characteristics and uses of minerals and rocks and recognizing that rocks are mixtures of minerals<br>**GLE-8.16** Compare the physical characteristics of rock and mineral specimens to observe that a rock is a mixture of minerals<br>**GLE-8.18** Describe how sedimentary, igneous, and metamorphic rocks form and change in the rock cycle | 2 | MD/ IC | ESS-M-A6 - rock cycle<br>ESS-M-A5 - states "identify characteristics of minerals and rocks" |
| **E8.6:** Soil consists of weathered rocks and decomposed organic material from dead plants, animals, and bacteria. Soils are often found in layers with each having a different chemical composition and texture. | **ESS-M-A4** investigating how soils are formed from weathered rock and decomposed organic material<br>**GLE-5.30** Identify organic and inorganic matter in soil samples with the aid of a hand lens or microscope<br>**GLE-8.15** Illustrate the role of organic processes in soil formation | 2 | MD | First part covered but Louisiana does not go into "chemical composition and texture" |
| **E8.7:** The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor. The atmosphere has a different physical and chemical composition at different elevations. | **GLE-8.26** Describe and illustrate the layers of Earth's atmosphere | 2 | MC | GLE does not mention composition of atmosphere. |
| ***Tectonics:*** *the basics of tectonic theory and Earth magnetism* | | | | |
| **E8.8:** The Earth is layered with a lithosphere; hot, convecting mantle; and dense, metallic core. | **ESS-M-A1** understanding that Earth is layered by density with an inner and outer core, a mantle, and a thin outer crust<br>**GLE-8.8** Identify and describe the four density layers of Earth<br>**GLE-8.10** Illustrate the movement of convection currents | 3 | | |

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Earth and space science | | | | | |
| EARTH STRUCTURES | **E8.9:** Lithospheric plates on the scale of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions. | **ESS-M-A2** understanding that Earth's crust and solid upper mantle are dividing plates that move in response to convection currents (energy transfers) in the mantle<br>**ESS-M-A3** investigating the characteristics of earthquakes and volcanoes and identifying zones where they may occur<br>**GLE-8.11** Illustrate the movements of lithospheric plates as stated in the plate tectonics theory<br>**GLE-8.12** Identify the edges of plate boundaries as likely areas of earthquakes and volcanic action | 2 | MD | |
| | **E8.10:** Earth as a whole has a magnetic field that is detectable at the surface with a compass. Earth's magnetic field is similar to the field of a natural or human-made magnet with north and south poles and lines of force. For thousands of years, people have used compasses to aid in navigation on land and sea. | **GLE-8.4** Demonstrate that Earth has a magnetic field by using magnets and compasses | 2 | MD | |
| EARTH SYSTEMS | ***Energy in Earth systems:*** *the sun's observable effects* | | | | |
| | **E8.11:** The sun is the major source of energy for phenomena on Earth's surface. The sun provides energy for plants to *grow and **drives convection within the atmosphere and oceans, producing winds, ocean currents, and the water cycle. | **PS-M-C3** understanding that the Sun is a major source of energy and that energy arrives at Earth's surface as light with a range of wavelengths<br>**ESS-M-C6** modeling and describing how radiant energy from the Sun affects phenomena on the Earth's surface, such as winds, ocean currents, and the water cycle<br>**GLE-8.44** Describe how unequal heating of Earth's surface affects movement of air masses and water in the atmosphere and hydrosphere | 2 | MD | PS-M-C3—Sun as major source<br>ESS-M-C6—Effects of sun |
| | **E8.12:** Seasons result from annual variations in the intensity of sunlight and length of day, due to the tilt of Earth's rotation axis relative to the plane of its yearly orbit around the sun. | **ESS-M-C7** modeling and explaining how seasons result from variations in amount of the Sun's energy hitting the surface due to the tilt of Earth's rotation on its axis and the length of the day<br>**GLE-8.45** Explain how seasonal changes are caused by the tilt of Earth as it rotates on its axis and revolves around the Sun<br>**GLE-8.46** Illustrate and explain how the angle at which sunlight strikes Earth produces changes in the seasons and length of daylight | 3 | MD | |

(CONTINUED)

TABLE D1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 8 science and Louisiana grade 8 benchmarks and grade level expectations**

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Earth and space science | | | | |
| **EARTH SYSTEMS** | ***Climate and Weather:*** *global weather patterns* | | | |
| **E8.13:** Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate because water in the oceans holds a large amount of heat. | **ESS-M-A11** understanding that the atmosphere interacts with the hydrosphere to affect weather and climate conditions<br>**GLE-8.27** Identify different air masses, jet streams, global wind patterns, and other atmospheric phenomena and describe how they relate to weather events, such as El Niño and La Niña<br>**GLE-8.44** Describe how unequal heating of Earth's surface affects movement of air masses and water in the atmosphere and hydrosphere | 2 | IC | State does not mention the heat-retaining properties of the oceans and the resultant effect upon local weather. |
| | ***Biogeochemical cycles:*** *natural and human-induced changes in Earth materials and systems* | | | |
| **E8.14:** Water, which covers the majority of Earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates from Earth's surface, rises and cools as it moves to higher elevations, condenses as clouds, falls as rain or snow, and collects in lakes, oceans, soil, and underground. | **ESS-M-A10** explaining (illustrating) how water circulates–on and through the crust, in the oceans, and in the atmosphere–in the water cycle<br>**ESS-M-A11** understanding that the atmosphere interacts with the hydrosphere to affect weather and climate conditions<br>**GLE-5.46** Identify and explain the interaction of the processes of the water cycle<br>**GLE-8.23** Explain the processes of evaporation, condensation, precipitation, infiltration, transpiration, and sublimation as they relate to the water cycle<br>**GLE-8.25** Explain and give examples of how climatic conditions on Earth are affected by the proximity of water | 3 | | |

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Earth and space science | | | | | |
| EARTH SYSTEMS | **E8.15:** Human activities, such as reducing the amount of forest cover, increasing the amount and variety of chemicals released into the atmosphere, and intensive farming, have changed Earth's land, oceans, and atmosphere. Studies of plant and animal populations have shown that such activities can reduce the number and variety of wild plants and animals and sometimes result in the extinction of species. | **SE-M-A3** defining the concept of pollutant and describing the effects of various pollutants on ecosystems<br>**SE-M-A4** understanding that human actions can create risks and consequences in the environment<br>**GLE-7.43** Identify and analyze the environmental impact of humans' use of technology (e.g., energy production, agriculture, transportation, human habitation)<br>**GLE-8.50** Illustrate possible point and non-point source contributions to pollution and natural or human-induced pathways of a pollutant in an ecosystem<br>**GLE-8.51** Analyze the consequences of human activities on global Earth systems | 2 | IC<br>MD | State does not describe specific human actions and their ecological impact. |

a. Rating is based on a scale of 1 to 3, where 1 indicates that state standards do not address NAEP content statement, 2 that state standards partially address NAEP content statement, and 3 that state standards fully address or exceed NAEP content statement by targeted grade level.

b. Codes are IC (implied content), LG (content covered at a lower grade level), HG (content covered at a higher grade level), MC (more content), and MD (more detailed content). See appendix C for further information.

TABLE D2

**Louisiana grade 8 standards not covered by National Assessment of Educational Progress grade 8 content**

| Content area | Louisiana grade 8 standards |
|---|---|
| Science as inquiry | SI-M-A1, SI-M-A2, SI-M-A3, SI-M-A4, SI-M-A5, SI-M-A6, SI-M-A7, SI-M-A8 SI-M-B1, SI-M-B2, SI-M-B3, SI-M-B4, SI-M-B5, SI-M-B6, SI-M-B7 |
| Physical science | PS-M-A 8,PS-M-B3, PS-M-B5, PS-M-C4, PS-M-C6, PS-M-C7, PS-M-C8 |
| Life science | LS-M-A1, LS-M-A3, LS-M-A5, LS-M-A6, LS-M-A7, LS-M-B2, LS-M-B3, LS-M-C2, LS-M-C3 |
| Earth and space science | ESS-M-A3, ESS-M-A7, ESS-M-A8, ESS-M-A9, ESS-M-A12, ESS-M-B2, ESS-M-B3, ESS-M-C8, ESS-M-C1 |
| Science and the environment | SE-M-A1, SE-M-A2, SE-E-A6, SE-M-A7, SE-M-A8, SE-M-A9, SE-M-A10 |

## APPENDIX E
## CONTENT ALIGNMENT FOR GRADE 12

TABLE E1

**Alignment of National Assessment of Educational Progress grade 12 science and Louisiana grade 11 benchmarks and grade level expectations**

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Physical science | | | | |
| **MATTER** | ***Properties of matter:*** *characteristics of subatomic particles and atomic structure* | | | |
| **P12.1:** Differences in the physical properties of solids, liquids, and gases are explained by the ways in which the atoms, ions, or molecules of the substances are arranged and the strength of the forces of attraction between the atoms, ions, or molecules. | **PS-H-C3** understanding that physical properties of substances reflect the nature of interactions among its particles<br>**PS-H-C4** separating mixtures based upon the physical properties of their components<br>**PS-H-C7** using the kinetic theory to describe the behavior of atoms and molecules during phase changes and to describe the behavior of matter in its different phases<br>**GLE HS PS.11** Investigate and classify common materials as *elements*, *compounds*, or *mixtures* (heterogeneous or homogeneous) based on their physical and chemical properties<br>**GLE HS C.24** Describe the influence of intermolecular forces on the physical and chemical properties of covalent compounds | 2 | IC | PS-H-C4 says separating mixtures based on physical properties; it includes arrangement and forces |
| **P12.2:** Electrons, protons, and neutrons are parts of the atom and have measurable properties including mass and, in the case of protons and electrons, charge. The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the particles of the nucleus together against the electrical repulsion between the protons. | **PS-H-B1** describing the structure of the atom and identifying and characterizing the particles that compose it (including the structure and properties of isotopes)<br>**PS-H-A2** understanding the language of chemistry (formulas, equations, symbols) and its relationship to molecules, atoms, ions, and subatomic particles<br>**GLE HS PS.5** Determine the number of protons, neutrons, and electrons of elements by using the atomic number and atomic mass from the periodic table<br>**GLE HS PS.6** Describe the results of loss/gain of electrons on charges of atoms | 3 | IC | PS-H-A2: if you understand "the language of chemistry" then you should know what the NAEP terms are. |

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| MATTER | **P12.3:** In the Periodic Table, elements are arranged according to the number of protons (called the atomic number). This organization illustrates commonality and patterns of physical and chemical properties among the elements. | **PS-H-C2** discovering the patterns of physical and chemical properties found on the periodic table of the elements<br>**PS-H-C3** understanding that physical properties of substances reflect the nature of interactions among its particles<br>**GLE HS PS.12** Classify elements as *metals* or *nonmetals* based on their positions in the periodic table<br>**GLE HS C.15** Predict the physical and chemical properties of an element based only on its location in the periodic table | 3 | IC<br>IC | PS-H-C2: atomic number implied in LA, but NAEP also includes chemical<br>PS-H-C3: interaction of particles, etc in LA—I would assume they would teach patterns and arrangement. |
| | **P12.4:** In a neutral atom, the positively charged nucleus is surrounded by the same number of negatively charged electrons. Atoms of an element whose nuclei have different numbers of neutrons are called isotopes. | **PS-H-B1** describing the structure of the atom and identifying and characterizing the particles that compose it (including the structure and properties of isotopes)<br>**PS-H-B2** describing the nature and importance of radioactive isotopes and nuclear reactions (fission, fusion, radioactive decay)<br>**GLE HS PS.5** Determine the number of protons, neutrons, and electrons of elements by using the atomic number and atomic mass from the periodic table<br>**GLE HS PS.6** Describe the results of loss/gain of electrons on charges of atoms | 3 | | PS-H-B2: Structure of isotopes is covered in LA, not importance. NAEP also includes nuclear reactions |
| | ***Changes in matter:*** *particulate nature of matter, unique physical characteristics of water, and changes at the atomic and molecular level during chemical changes* | | | | |
| | **P12.5:** Changes of state require a transfer of energy. Water has a very high specific heat, meaning it can absorb a large amount of energy while producing only small changes in temperature. | **PS-H-C7** using the kinetic theory to describe the behavior of atoms and molecules during phase changes and to describe the behavior of matter in its different phases<br>**GLE HS PS.19** Analyze and interpret a graph that relates temperature and heat energy absorbed during phase changes of water<br>**GLE HS C.43** Graph and compute the energy changes that occur when a substance, such as water, goes from a solid to a liquid state, and then to a gaseous state | 2 | IC | Kinetic theory is stated in LA, but do they cover it in this detail? |

(CONTINUED)

TABLE E1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 12 science and Louisiana grade 11 benchmarks and grade level expectations**

| | NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| MATTER | **P12.6:** An atom's electron configuration, particularly of the outermost electrons, determines how the atom can interact with other atoms. The interactions between atoms that hold them together in molecules or between oppositely charged ions are called chemical bonds. | **PS-H-B3** understanding that an atom's electron configuration, particularly that of the outermost electrons, determines the chemical properties of that atom<br>**PS-H-C1** distinguishing among elements, compounds, and/or mixtures<br>**PS-H-C5** understanding that chemical bonds are formed between atoms when the outermost electrons are transferred or shared to produce ionic and covalent compounds<br>**GLE HS PS.6** Determine the number of protons, neutrons, and electrons of elements by using the atomic number and atomic mass from the periodic table<br>**GLE HS PS.10** Identify the number of valence electrons of the first 20 elements based on their positions in the periodic table<br>**GLE HS PS.15** Using selected elements from atomic numbers 1 to 20, draw Bohr models<br>**GLE HS C.13** Identify the number of bonds an atom can form given the number of valence electrons | 3 | IC<br>IC<br>IC | PS-H-B3 says it determines chemical properties of an atom. It doesn't specifically state that it determines atom interaction.<br>PS-H-C1 says distinguish among elements, compounds, mixtures- that is atom interaction.<br>PS-H-C5 types of chemical bonds are discussed in LA |

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| MATTER | **P12.7:** A large number of important reactions involve the transfer of either electrons (oxidation/reduction reactions) or hydrogen ions (acid/base reactions) between reacting ions, molecules, or atoms. In other chemical reactions, atoms interact with one another by sharing electrons to create a bond. An important example is carbon atoms, which can bond to one another in chains, rings, and branching networks to form, along with other kinds of atoms—hydrogen, oxygen, nitrogen, and sulfur—a variety of structures, including synthetic polymers, oils, and the large molecules essential to life. | **PS-H-C5** understanding that chemical bonds are formed between atoms when the outermost electrons are transferred or shared to produce ionic and covalent compounds<br>**PS-H-C6** recognizing that carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures<br>**PS-H-D7** identifying important chemical reactions that occur in living systems, the home, industry, and the environment<br>**PS-H-D2** comparing, contrasting, and measuring the pH of acids and bases using a variety of indicators<br>**GLE HS PS.10** Identify the number of valence electrons of the first 20 elements based on their positions in the periodic table<br>**GLE HS PS.17** Name and predict the bond type formed between selected elements based on their locations in the periodic table<br>**GLE HS PS.18** Diagram or construct models of simple hydrocarbons (four or fewer carbons) with single, double, or triple bonds<br>**GLE HS PS.22** Identify evidence of chemical changes<br>**GLE HS PS.23** Classify unknowns as *acidic*, *basic*, or *neutral* using indicators<br>**GLE HS PS.24** Identify balanced equations as neutralization, combination, and decomposition reactions<br>**GLE HS C.13** Identify the number of bonds an atom can form given the number of valence electrons | 3 | IC<br>MD | PS-H-C5-Ionic/ Covalent is used in LA, not redox or acid/base reactions as in NAEP.<br>PS-H-C6- H, O, N, S are stated on NAEP<br>PS-H-D7- Is this what they mean in State?<br>PS-H-D2- Probably finding pH of acids/ bases if looking at rxns. |

(CONTINUED)

TABLE E1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 12 science and Louisiana grade 11 benchmarks and grade level expectations**

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Physical science | | | | |
| ENERGY | ***Forms of energy*:** *nuclear energy and waves* | | | |
| **P12.8:** Atoms and molecules that compose matter are in constant motion (translational, rotational, or vibrational). | **PS-H-C7** using the kinetic theory to describe the behavior of atoms and molecules during phase changes and to describe the behavior of matter in its different phases<br>**GLE HS PS.20** Predict the particle motion as a substance changes phases<br>**GLE HS C.29** Predict the properties of a gas based on gas laws (e.g., temperature, pressure, volume) | 3 | IC | LA states Kinetic theory to describe behavior of atoms and molecules during phase changes |
| **P12.9:** Energy may be transferred from one object to another during collisions. | **PS-H-D5** applying the law of conservation of matter to chemical reactions<br>**PS-H-F2** applying the universal law of conservation of matter, energy, and momentum, and recognizing their implications<br>**PS-H-F1** describing and representing relationships among energy, work, power, and efficiency | 2 | IC<br>IC | PS-H-D5: Law of Conservation of Matter is used in LA<br>PS-H-F2: applying universal law of conservation of matter—momentum?<br>PS-H-F1: NAEP mentions collision |
| **P12.10:** Electromagnetic waves are produced by changing the motion of charges or by changing magnetic fields. The energy of electromagnetic waves is transferred to matter in packets. The energy content of the packets is directly proportional to the frequency of the electromagnetic waves. | **PS-H-G2** analyzing the relationship and interaction of magnetic and electrical fields and the forces they produce<br>**PS-H-G3** characterizing and differentiating electro-magnetic and mechanical waves and their effects on objects as well as humans<br>**GLE HS PS.42** Describe the relationship between wavelength and frequency<br>**GLE HS PS.48** Compare properties of waves in the electromagnetic spectrum<br>**GLE HS P.32** Compare properties of electromagnetic and mechanical waves<br>**GLE HS P.34** Compare the properties of the electromagnetic spectrum as a wave and as a particle | 3 | MC | NAEP goes in much more detail than LA benchmarks. |

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| ENERGY | **P12.11:** Fission and fusion are reactions involving changes in the nuclei of atoms. Fission is the splitting of a large nucleus into smaller nuclei and particles. Fusion involves joining of two relatively light nuclei at extremely high temperature and pressure. Fusion is the process responsible for the energy of the sun and other stars. | **PS-H-B2** describing the nature and importance of radioactive isotopes and nuclear reactions (fission, fusion, radioactive decay)<br>**GLE HS PS.9** Compare nuclear fission to nuclear fusion | 2 | IC | NAEP does not include radioactive decay (but that is in ESS)<br>LA discusses nature and importance of fission and fusion while NAEP defines fission and fusion |
| | ***Energy transfer and conservation:*** *translational, rotational, and vibrational energy of atoms and molecules, and chemical and nuclear reactions* | | | | |
| | **P12.12:** Heating increases the translational, rotational, and vibrational energy of the atoms composing elements and the molecules or ions composing compounds. As the translational energy of the atoms, molecules, or ions increases, the temperature of the matter increases. Heating a sample of a crystalline solid increases the vibrational energy of the atoms, molecules, or ions. When the vibrational energy becomes great enough, the crystalline structure breaks down and the solid melts. | **PS-H-D6** comparing and contrasting the energy changes that accompany changes in matter<br>**PS-H-D7** identifying important chemical reactions that occur in living systems, the home, industry, and the environment<br>**GLE HS PS.20** Predict the particle motion as a substance changes phases | 2 | MD | LA says comparing and contrasting energy changes and changes in matter but NAEP is specific to heating |
| | **P12.13:** The potential energy of an object on Earth's surface is increased when the object's position is changed from one closer to Earth's surface to one farther from Earth's surface. | **GLE HS PS.38** Analyze diagrams to identify changes in kinetic and potential energy | 1 | | |
| | **P12.14:** Chemical reactions either release energy to the environment (exothermic) or absorb energy from the environment (endothermic). | **PS-H-D6** comparing and contrasting the energy changes that accompany changes in matter<br>**GLE HS PS.27** Distinguish between endothermic and exothermic reactions<br>**GLE HS C.31** Describe chemical changes and reactions using diagrams and descriptions of the reactants, products, and energy changes<br>**GLE HS C.42** Differentiate between activation energy in endothermic reactions and exothermic reactions | 3 | IC<br>MC | LA says energy changes that accompany changes in matter. |

(CONTINUED)

TABLE E1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 12 science and Louisiana grade 11 benchmarks and grade level expectations**

| | NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| MOTION | **P12.15:** Nuclear reactions—fission and fusion—convert very small amounts of matter into appreciable amounts of energy. | **PS-H-B2** describing the nature and importance of radioactive isotopes and nuclear reactions (fission, fusion, radioactive decay)<br>**ESS-H-A3** explaining fission and fusion in relation to Earth's internal and external heat sources | 3 | | |
| | **P12.16:** Total energy is conserved in a closed system. | **PS-H-D5** applying the law of conservation of matter to chemical reactions<br>**GLE HS PS.40** Demonstrate energy transformation and conservation in everyday actions<br>**GLE HS P.22** Analyze energy transformations using the law of conservation of energy | 3 | | |
| | ***Motion at the macroscopic level*:** *velocity and acceleration as quantitative descriptions of motion and the representation of linear velocity and acceleration in tables and graphs* | | | | |
| | **P12.17:** The motion of an object can be described by its position and velocity as functions of time and by its average speed and average acceleration during intervals of time. | **PS-H-E2** understanding the relationship of displacement, time, rate of motion, and rate of change of motion; representing rate and changes of motion mathematically and graphically<br>**PS-H-E4** illustrating how frame of reference affects our ability to judge motion<br>**GLE HS PS.31** Differentiate between speed and velocity<br>**GLE HS PS.32** Plot and compare line graphs of acceleration and velocity<br>**GLE HS PS.33** Calculate velocity and acceleration using equations<br>**GLE HS P.9** Describe and measure motion in terms of position, displacement time, and the derived quantities of velocity and acceleration<br>**GLE HS P.10** Determine constant velocity and uniform acceleration mathematically and graphically<br>**GLE HS P.13** Solve for missing variables in kinematic equations relating to actual situations | 3 | MD | Velocity, position, acceleration vocabulary not used in state<br>PS-H-E2: LA mentions mathematically and graphically |

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| MOTION | **P12.18:** Objects undergo different kinds of motion—translational, rotational, and vibrational. | **PS-H-E1** recognizing the characteristics and relative strengths of the forces of nature (gravitational, electrical, magnetic, nuclear) | 2 | MD | State doesn't use translational, rotational, vibrational—they use gravitational, electrical, magnetic, nuclear. |
| | ***Forces affecting motion:*** *quantitative descriptions of universal gravitational and electric forces, and relationships among force, mass, and acceleration* | | | | |
| | **P12.19:** The motion of an object changes only when a net force is applied. | **PS-H-E3** understanding effects of forces on changes in motion as explained by Newtonian mechanics<br>**GLE HS PS.34** Demonstrate Newton's three laws of motion (e.g., inertia, net force using F = ma, equal and opposite forces) | 2 | IC | LA states Newtonian mechanics |
| | **P12.20:** The magnitude of acceleration of an object depends directly on the strength of the net force and inversely on the mass of the object. This relationship ($a=F_{net}/m$) is independent of the nature of the force. | **PS-H-E1** recognizing the characteristics and relative strengths of the forces of nature (gravitational, electrical, magnetic, nuclear)<br>**PS-H-E2** understanding the relationship of displacement, time, rate of motion, and rate of change of motion; representing rate and changes of motion mathematically and graphically<br>**GLE HS PS.34** Demonstrate Newton's three laws of motion (e.g., inertia, net force using F = ma, equal and opposite forces)<br>**GLE HS P.13** Solve for missing variables in kinematic equations relating to actual situations | 3 | IC | PS-H-E2: LA doesn't state acceleration, but it covers time, rate of motion, changes of motion, etc.<br>NAEP uses a formula; LA benchmarks do not include the formula but GLE HS PS.34 does. |
| | **P12.21:** Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted by the second object back on the first object. In closed systems, momentum is the quantity of motion that is conserved. Conservation of momentum can be used to help validate the relationship $a=F_{net}/m$. | **PS-H-F2** applying the universal law of conservation of matter, energy, and momentum, and recognizing their implications<br>**PS-H-E2** understanding the relationship of displacement, time, rate of motion, and rate of change of motion; representing rate and changes of motion mathematically and graphically<br>**PS-H-E3** understanding effects of forces on changes in motion as explained by Newtonian mechanics<br>**GLE HS PS.34** Demonstrate Newton's three laws of motion (e.g., inertia, net force using F = ma, equal and opposite forces)<br>**GLE HS P.13** Solve for missing variables in kinematic equations relating to actual situations | 3 | MD | LA mentions universal law of conservation of matter, energy, and momentum<br>NAEP uses a formula; LA benchmarks do not include the formula but GLE HS PS.34 does. |

(CONTINUED)

TABLE E1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 12 science and Louisiana grade 11 benchmarks and grade level expectations**

| | NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Physical science | | | | | |
| MOTION | **P12.22:** Gravitation is a universal attractive force that each mass exerts on any other mass. The strength of the gravitational force between two masses is proportional to the masses and inversely proportional to the square of the distance between them. | **PS-H-E1** recognizing the characteristics and relative strengths of the forces of nature (gravitational, electrical, magnetic, nuclear)<br>**ESS-M-C3** investigating the force of gravity and the ways gravity governs motion in the solar system and objects on Earth<br>**GLE HS PS.29** Differentiate between *mass* and *weight*<br>**GLE HS P.7** Relate gravitational force to mass and distance | 3 | | Matching Louisiana standard is found in middle school (ESS-M-C3) |
| | **P12.23:** Electric force is a universal force that exists between any two charged objects. Opposite charges attract while like charges repel. The strength of the electric force is proportional to the magnitudes of the charges and inversely proportional to the square of the distance between them. Between any two charged particles, the electric force is vastly greater than the gravitational force. | **PS-H-E1** recognizing the characteristics and relative strengths of the forces of nature (gravitational, electrical, magnetic, nuclear)<br>**GLE HS PS.30** Compare the characteristics and strengths of forces in nature (e.g., gravitational, electrical, magnetic, nuclear) | 3 | | |
| Life science | | | | | |
| STRUCTURES AND FUNCTIONS OF LIVING SYSTEMS | ***Organization and Development:*** *basic needs of organisms: the chemical basis of living systems* | | | | |
| | **L12.1:** Living systems are made of complex molecules (including carbohydrates, fats, proteins, and nucleic acids) that consist mostly of a few elements, especially carbon, hydrogen, oxygen, nitrogen, and phosphorous. | **PS-H-C6** recognizing that carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures<br>**GLE HS PS.18** Diagram or construct models of simple hydrocarbons (four or fewer carbons) with single, double, or triple bonds | 2 | IC | LA: Carbon atoms make a variety of structures |
| | **L12.2:** Cellular processes are carried out by many different types of molecules, mostly proteins. Protein molecules are long, usually folded chains made from combinations of amino-acid molecules. Protein molecules assemble fats and carbohydrates and carry out other cellular functions. The function of each protein molecule depends on its specific sequence of amino acids and the shape of the molecule. | **PS-H-D4** analyzing the factors that affect the rate and equilibrium of a chemical reaction<br>**LS-H-A1** observing cells, identifying organelles, relating structure to function, and differentiating among cell types<br>**LS-H-A2** demonstrating a knowledge of cellular transport<br>**GLE HS PS.18** Diagram or construct models of simple hydrocarbons (four or fewer carbons) with single, double, or triple bonds<br>**GLE HS Bio.3** Investigate and describe the role of enzymes in the function of a cell | 2 | IC<br>IC<br>IC | PS-H-D4: LA Enzymes and rxn rates?<br>LS-H-A1: LA Cell structure and function<br>LS-H-A2: LA Cell Transport |

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Life science | | | | |
| **STRUCTURES AND FUNCTIONS OF LIVING SYSTEMS** | | | | |
| **L12.3:** Cellular processes are regulated both internally and externally by environments in which cells exist, including local environments that lead to cell differentiation during the development of multicellular organisms. During the development of complex multicellular organisms, cell differentiation is regulated through the expression of different genes. | **LS-H-A1** observing cells, identifying organelles, relating structure to function, and differentiating among cell types<br>**LS-H-A3** investigating cell differentiation and describing stages of embryological development in representative organisms<br>**LS-H-A2** demonstrating a knowledge of cellular transport<br>**GLE HS Bio.2** Identify and describe structural and functional differences among organelles<br>**GLE HS Bio.6** Analyze a diagram of a developing zygote to determine when cell differentiation occurs | 2 | IC<br>MC | LS-H-A1: LA Cell Structure and Function<br>LS-H-A3: LA Cell differentiation and development |
| ***Matter and energy transformations:*** *the chemical basis of matter and energy transformation in living systems* | | | | |
| **L12.4:** Plants have the capability (through photosynthesis) to take energy from light to form higher energy sugar molecules containing carbon, hydrogen, and oxygen from lower energy molecules. These sugar molecules can be used to make amino acids and other carbon-containing (organic) molecules and assembled into larger molecules with biological activity (including proteins, DNA, carbohydrates, and fats). | **LS-H-E1** comparing and contrasting photosynthesis and cellular respiration emphasizing their relationships<br>**LS-H-E2** recognizing the importance of the ATP cycle in energy usage within the cell<br>**SE-H-A7** comparing and contrasting the dynamic interaction within the biosphere<br>**GLE HS Bio.28** Explain why ecosystems require a continuous input of energy from the Sun<br>**GLE HS Bio.29** Use balanced equations to analyze the relationship between photosynthesis and cellular respiration<br>**GLE HS Bio.30** Explain the role of adenosine triphosphate (ATP) in a cell | 2 | MC<br>IC<br>MC | LS-H-E1: Compare and contrast photosynthesis and cellular respiration<br>LS-H-E2: ATP and energy usage in a cell<br>SE-H-A7 states, "dynamic interaction within the biosphere" it is assumed that this means photosynthesis and respiration |

(CONTINUED)

TABLE E1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 12 science and Louisiana grade 11 benchmarks and grade level expectations**

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Life science | | | | | |
| **STRUCTURES AND FUNCTIONS OF LIVING SYSTEMS** | **L12.5:** The chemical elements that make up the molecules of living things pass through food webs and are combined and recombined in different ways. At each link in an ecosystem, some energy is stored in newly made structures, but much is dissipated into the environment as heat. Continual input of energy from sunlight keeps the process going. | **LS-H-D1** illustrating the biogeochemical cycles and explaining their importance<br>**LS-H-D2** describing trophic levels and energy flows<br>**LS-H-D3** investigating population dynamics<br>**LS-H-E3** differentiating among levels of biological organization<br>**LS-H-E1** comparing and contrasting photosynthesis and cellular respiration emphasizing their relationships<br>**SE-H-A11** understanding how pollutants can affect living systems<br>**LS-M-C2** modeling and interpreting food chains and food webs<br>**GLE HS Bio.23** Illustrate the flow of carbon, nitrogen, and water through an ecosystem<br>**GLE HS Bio.24** Analyze food webs by predicting the impact of the loss or gain of an organism<br>**GLE HS Bio.25** Evaluate the efficiency of the flow of energy and matter through a food chain/ pyramid<br>**GLE HS Bio.28** Explain why ecosystems require a continuous input of energy from the Sun<br>**GLE HS Bio.29** Use balanced equations to analyze the relationship between photosynthesis and cellular respiration<br>**GLE HS EnvirSci.8** Explain how species in an ecosystem interact and link in a complex web | 3 | | |

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Life science | | | | | |
| STRUCTURES AND FUNCTIONS OF LIVING SYSTEMS | **L12.6:** As matter cycles and energy flows through different levels of organization of living systems—cells, organs, organisms, communities—and between living systems and the physical environment, chemical elements are recombined in different ways. Each recombination results in storage and dissipation of energy into the environment as heat. Matter and energy are conserved in each change. | **LS-H-E3** differentiating among levels of biological organization<br>**LS-H-E2** recognizing the importance of the ATP cycle in energy usage within the cell<br>**LS-H-D1** illustrating the biogeochemical cycles and explaining their importance<br>**LS-H-D2** describing trophic levels and energy flows<br>**LS-H-D3** investigating population dynamics<br>**SE-H-A2** investigating the flow of energy in ecological systems<br>**GLE HS Bio.23** Illustrate the flow of carbon, nitrogen, and water through an ecosystem<br>**GLE HS Bio.24** Analyze food webs by predicting the impact of the loss or gain of an organism<br>**GLE HS Bio.25** Evaluate the efficiency of the flow of energy and matter through a food chain/pyramid<br>**GLE HS Bio.26** Analyze the dynamics of a population with and without limiting factors<br>**GLE HS Bio.31** Compare the levels of organization in the biosphere | 2 | MC<br>MC<br>MC<br>MC<br>IC | |

(CONTINUED)

TABLE E1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 12 science and Louisiana grade 11 benchmarks and grade level expectations**

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Life science | | | | |
| STRUCTURES AND FUNCTIONS OF LIVING SYSTEMS | ***Interdependence:*** *consequences of interdependence* | | | |
| **L12.7:** Although the interrelationships and interdependence of organisms may generate biological communities in ecosystems that are stable for hundreds or thousands of years, ecosystems always change when climate changes or when one or more new species appear as a result of migration or local evolution. The impact of the human species has major consequences for other species. | **LS-H-D4** exploring how humans have impacted ecosystems and the need for societies to plan for the future<br>**SE-H-B3** recognizing that population size and geographic and economic factors result in the inequitable distribution of Earth's resources<br>**SE-H-A11** understanding how pollutants can affect living systems<br>**SE-H-A8** analyzing evidence that plant and animal species have evolved physical, biochemical, and/or behavioral adaptations to their environments<br>**SE-H-A9** demonstrating an understanding of influencing factors of biodiversity<br>**SE-H-A4** understanding that change is a fundamental characteristic of every ecosystem and that ecosystems have varying capacities for change and recovery<br>**SE-H-A1** demonstrating an understanding of the functions of Earth's major ecological systems<br>**LS-H-D3** investigating population dynamics<br>**GLE HS Bio.26** Analyze the dynamics of a population with and without limiting factors<br>**GLE HS Bio.27** Analyze positive and negative effects of human actions on ecosystems<br>**GLE HS EnvirSci.1** Describe the abiotic and biotic factors that distinguish Earth's major ecological systems<br>**GLE HS EnvirSci.2** Describe the characteristics of major biomes on Earth<br>**GLE HS EnvirSci.5** Examine and discuss the major stages of succession, describing the generalized sequential order of the types of plant species<br>**GLE HS EnvirSci.9** Cite and explain examples of organisms' adaptations to environmental pressures over time | 2 | MC<br>IC<br>IC<br>IC<br>IC<br>IC | |

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Life science | | | | | |
| STRUCTURES AND FUNCTIONS OF LIVING SYSTEMS | **L12.7 (continued)** | **GLE HS EnvirSci.10** Analyze the effect of an invasive species on the biodiversity within ecosystems<br>**GLE HS EnvirSci.11** Explain why biodiversity is essential to the survival of organisms<br>**GLE HS EnvirSci.12** Give examples and describe the effect of pollutants on selected populations | 2 | MC<br>IC<br>IC<br>IC<br>IC<br>IC | |
| CHANGES IN LIVING SYSTEMS | ***Heredity and reproduction:*** *the molecular basis of heredity* | | | | |
| | **L12.8:** Hereditary information is contained in genes, located in the chromosomes of each cell. A human cell contains many thousands of different genes. One or many genes can determine an inherited trait of an individual, and a single gene can influence more than one trait. | **LS-H-A3** investigating cell differentiation and describing stages of embryological development in representative organisms<br>**LS-H-B3** describing the transmission of traits from parent to offspring and the influence of environmental factors on gene expression<br>**SE-H-A9** demonstrating an understanding of influencing factors of biodiversity<br>**LS-H-B1** explaining the relationship among chromosomes, DNA, genes, RNA, and proteins<br>**GLE HS Bio.10** Analyze pedigrees to identify patterns of inheritance for common genetic disorders<br>**GLE HS Bio.11** Calculate the probability of genotypes and phenotypes of offspring given the parental genotypes | 3 | | |

(CONTINUED)

TABLE E1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 12 science and Louisiana grade 11 benchmarks and grade level expectations**

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Life science | | | | | |
| **CHANGES IN LIVING SYSTEMS** | **L12.9:** The genetic information encoded in DNA molecules provides instructions for assembling protein molecules. Genes are segments of DNA molecules. Inserting, deleting, or substituting DNA segments can alter genes. An altered gene may be passed on to every cell that develops from it. The resulting features may help, harm, or have little or no effect on the offspring's success in its environment. | **LS-H-B1** explaining the relationship among chromosomes, DNA, genes, RNA, and proteins<br>**LS-H-B3** describing the transmission of traits from parent to offspring and the influence of environmental factors on gene expression<br>**GLE HS Bio.7** Identify the basic structure and function of nucleic acids (e.g., DNA, RNA)<br>**GLE HS Bio.8** Describe the relationships among DNA, genes, chromosomes, and proteins | 2 | IC | No mutations in State, but can be implied with influence of environmental factors on gene expression LS-H-B3 deals with the first two sentences in the NAEP standard. |
| | **L12.10:** Sorting and recombination of genes in sexual reproduction results in a great variety of possible gene combinations from the offspring of any two parents. | **LS-H-B3** describing the transmission of traits from parent to offspring and the influence of environmental factors on gene expression<br>**LS-H-B2** comparing and contrasting mitosis and meiosis<br>**GLE HS Bio.9** Compare mitosis and meiosis<br>**GLE HS Bio.10** Analyze pedigrees to identify patterns of inheritance for common genetic disorders<br>**GLE HS Bio.11** Calculate the probability of genotypes and phenotypes of offspring given the parental genotypes | 3 | | |
| | ***Evolution and Diversity:*** *the mechanisms of evolutionary change and the history of life on Earth* | | | | |
| | **L12.11:** Modern ideas about evolution (including natural selection and common descent) provide a scientific explanation for the history of life on Earth as depicted in the fossil record and in the similarities evident within the diversity of existing organisms. | **LS-H-C1** exploring experimental evidence that supports the theory of the origin of life<br>**LS-H-C2** recognizing the evidence for evolution<br>**LS-H-C3** discussing the patterns, mechanisms, and rate of evolution<br>**GLE HS Bio.14** Analyze evidence on biological evolution, utilizing descriptions of existing investigations, computer models, and fossil records<br>**GLE HS Bio.15** Compare the embryological development of animals in different phyla<br>**GLE HS Bio.16** Explain how DNA evidence and fossil records support Darwin's theory of evolution<br>**GLE HS Bio.17** Explain how factors affect gene frequency in a population over time | 3 | | |

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Life science | | | | | |
| CHANGES IN LIVING SYSTEMS | **L12.12:** Molecular evidence substantiates the anatomical evidence for evolution and provides additional detail about the sequence in which various lines of descent branched. | **LS-H-C1** exploring experimental evidence that supports the theory of the origin of life<br>**LS-H-C2** recognizing the evidence for evolution<br>**LS-H-C3** discussing the patterns, mechanisms, and rate of evolution<br>**LS-H-C4** classifying organisms<br>**GLE HS Bio.14** Analyze evidence on biological evolution, utilizing descriptions of existing investigations, computer models, and fossil records<br>**GLE HS Bio.15** Compare the embryological development of animals in different phyla<br>**GLE HS Bio.16** Explain how DNA evidence and fossil records support Darwin's theory of evolution<br>**GLE HS Bio.17** Explain how factors affect gene frequency in a population over time<br>**GLE HS Bio.18** Classify organisms from different kingdoms at several taxonomic levels, using a dichotomous key | 3 | IC | |
| | **L12.13:** Evolution is the consequence of the interactions of (1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) the ensuing selection from environmental pressure of those organisms better able to survive and leave offspring. | **LS-H-C1** exploring experimental evidence that supports the theory of the origin of life<br>**LS-H-C2** recognizing the evidence for evolution<br>**LS-H-C3** discussing the patterns, mechanisms, and rate of evolution<br>**GLE HS Bio.14** Analyze evidence on biological evolution, utilizing descriptions of existing investigations, computer models, and fossil records<br>**GLE HS Bio.15** Compare the embryological development of animals in different phyla<br>**GLE HS Bio.16** Explain how DNA evidence and fossil records support Darwin's theory of evolution<br>**GLE HS Bio.17** Explain how factors affect gene frequency in a population over time | 3 | | |

(CONTINUED)

TABLE E1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 12 science and Louisiana grade 11 benchmarks and grade level expectations**

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Earth and space science | | | | | |
| EARTH IN SPACE AND TIME | ***Objects in the Universe*:** *a vision of the universe* | | | | |
| | **E12.1:** The origin of the universe remains one of the greatest questions in science. The "big bang" theory places the origin approximately 13.7 billion years ago when the universe began in a hot, dense state. According to this theory, the universe has been expanding ever since. | **ESS-H-D1** identifying scientific evidence that supports the latest theory of the age and origin of the universe<br>**GLE HS EarthSci.23** Identify the evidence that supports the big bang theory | 2 | MC | LA standards have to do with evidence |
| | **E12.2:** Early in the history of the universe, matter, primarily the light atoms hydrogen and helium, clumped together by gravitational attraction to form countless trillions of stars and billions of galaxies. | **ESS-H-D4** identifying the elements found in the Sun and other stars by investigating the spectra<br>**GLE HS EarthSci.26** Identify the elements present in selected stars, given spectrograms of known elements and those of the selected stars | 2 | MC | Using spectra |
| | **E12.3:** Stars, like the sun, transform matter into energy in nuclear reactions. When hydrogen nuclei fuse to form helium, a small amount of matter is converted to energy. These and other processes in stars have led to the formation of all the other elements. | **ESS-H-D5** describing the role of hydrogen in the formation of all the natural elements<br>**GLE HS EarthSci.27** Trace the movement and behavior of hydrogen atoms during the process of fusion as it occurs in stars like the Sun | 2 | MD | |

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Earth and space science | | | | |
| EARTH IN SPACE AND TIME | ***History of Earth:*** *theories about Earth's history* | | | |
| | **E12.4:** Early methods of determining geologic time, such as the use of index fossils and stratigraphic sequences, allowed for the relative dating of geological events. However, absolute dating was impossible until the discovery that certain radioactive isotopes in rocks have known decay rates, making it possible to determine how many years ago a given rock sample formed. | **PS-H-B2** describing the nature and importance of radioactive isotopes and nuclear reactions (fission, fusion, radioactive decay)<br>**ESS-H-C2** estimating the age of Earth by using dating techniques<br>**ESS-H-C4** examining fossil evidence as it relates to the evolution of life and the resulting changes in the amount of oxygen in the atmosphere<br>**ESS-H-D1** identifying scientific evidence that supports the latest theory of the age and origin of the universe<br>**GLE HS PS.11** Investigate and classify common materials as *elements*, *compounds*, or *mixtures* (heterogeneous or homogeneous) based on their physical and chemical properties<br>**GLE HS EarthSci.17** Determine the relative ages of rock layers in a geologic profile or cross section<br>**GLE HS EarthSci.18** Use data from radioactive dating techniques to estimate the age of earth materials<br>**GLE HS EarthSci.21** Use fossil records to explain changes in the concentration of atmospheric oxygen over time | 3 | | only radioactive decay<br>ESS-H-C2: NAEP mentions absolute dating |
| | **E12.5:** Theories of planet formation and radioactive dating of meteorites and lunar samples have led to the conclusion that the sun, Earth, and the rest of the solar system formed from a nebular cloud of dust and gas 4.6 billion years ago. | **ESS-H-C1** explaining the formation of the solar system from a nebular cloud of dust and gas<br>**ESS-H-C2** estimating the age of Earth by using dating technique<br>**GLE HS EarthSci.16** Use the nebular hypothesis to explain the formation of a solar system<br>**GLE HS EarthSci.17** Determine the relative ages of rock layers in a geologic profile or cross section<br>**GLE HS EarthSci.18** Use data from radioactive dating techniques to estimate the age of earth materials | 3 | | |

(CONTINUED)

TABLE E1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 12 science and Louisiana grade 11 benchmarks and grade level expectations**

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Earth and space science | | | | | |
| EARTH IN SPACE AND TIME | **E12.6:** Early Earth was very different from today's planet. Evidence for one-celled forms of life—the bacteria—extends back more than 3.5 billion years. The evolution of life caused dramatic changes in the composition of Earth's atmosphere, which did not originally contain molecular oxygen. | **SE-H-A7** comparing and contrasting the dynamic interaction within the biosphere<br>**SE-H-A8** analyzing evidence that plant and animal species have evolved physical, biochemical, and/or behavioral adaptations to their environments<br>**GLE HS EnvSci.9** Cite and explain examples of organisms' adaptations to environmental pressures over time | 2 | IC | Oxygen is implied in Louisiana |
| | **E12.7:** Earth's current structure has been influenced by both sporadic and gradual events. Changes caused by violent earthquakes and volcanic eruptions can be observed on a human time scale, but many geological processes, such as the building of mountain chains and shifting of entire continents, take place over hundreds of millions of years. | **SE-H-A6** describing and explaining Earth's bio-chemical and geochemical cycles and their relationship to ecosystem stability<br>**SE-H-A4** understanding that change is a fundamental characteristic of every ecosystem and that ecosystems have varying capacities for change and recovery<br>**ESS-H-C5** explaining that natural processes and changes in Earth's system may take place in a matter of seconds or develop over billions of years<br>**GLE HS EnvSci.5** Examine and discuss the major stages of succession, describing the generalized sequential order of the types of plant species<br>**GLE HS EarthSci.22** Analyze data related to a variety of natural processes to determine the time frame of the changes involved (e.g., formation of sedimentary rock layers, deposition of ash layers, fossilization of plant or animal species) | 2 | IC<br>IC<br>MD | ESS-H-C5- NAEP explains processes |

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Earth and space science | | | | |
| EARTH STRUCTURES | ***Tectonics:*** *the basics of tectonic theory and Earth magnetism* | | | |
| **E12.8:** Mapping of the Mid-Atlantic Ridge, evidence of sea floor spreading, and subduction provided crucial evidence in support of the theory of plate tectonics. The theory currently explains plate motion as follows: the outward transfer of Earth's internal heat propels the plates comprising Earth's surface across the face of the globe. Plates are pushed apart where magma rises to form mid-ocean ridges, and the edges of plates are pulled back down where Earth materials sink into the crust at deep trenches. | **ESS-H-A4** explaining how decay of radioactive isotopes and the gravitational energy from Earth's original formation generates Earth's internal heat<br>**ESS-H-A5** demonstrating how the Sun's radiant energy causes convection currents within the atmosphere and the oceans<br>**ESS-H-A7** modeling the transfer of Earth's internal heat by way of convection currents in the mantle which powers the movement of the lithospheric plates<br>**GLE HS EarthSci.6** Discuss how heat energy is generated at the inner core-outer core boundary<br>**GLE HS EarthSci.7** Analyze how radiant heat from the Sun is absorbed and transmitted by several different earth materials<br>**GLE HS EarthSci.11** Describe the processes that drive lithospheric plate movements (i.e., radioactive decay, friction, convection)<br>**GLE HS EarthSci.12** Relate lithospheric plate movements to the occurrences of earthquakes, volcanoes, mid-ocean ridge systems, and off-shore trenches found on Earth | 2 | IC<br>IC<br>MD | |
| EARTH SYSTEMS | ***Energy in earth systems:*** *internal and external sources of energy in Earth systems* | | | |
| **E12.9:** Earth systems have internal and external sources of energy, both of which create heat. The sun is the major external source of energy. Two primary sources of internal energy are the decay of radioactive isotopes and the gravitational energy from Earth's original formation. | **ESS-H-A4** explaining how decay of radioactive isotopes and the gravitational energy from Earth's original formation generates Earth's internal heat<br>**ESS-H-A3** explaining fission and fusion in relation to Earth's internal and external heat sources<br>**GLE HS EarthSci.5** Explain how the process of fusion inside the Sun provides the external heat source for Earth<br>**GLE HS EarthSci.6** Discuss how heat energy is generated at the inner core-outer core boundary<br>**GLE HS EarthSci.11** Describe the processes that drive lithospheric plate movements (i.e., radioactive decay, friction, convection) | 2 | IC | |

(CONTINUED)

TABLE E1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 12 science and Louisiana grade 11 benchmarks and grade level expectations**

| NAEP science standards | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|
| Earth and space science | | | | |
| EARTH SYSTEMS | ***Climate and Weather:*** *systems that influence climate* | | | |
| **E12.10:** Climate is determined by energy transfer from the sun at and near Earth's surface. This energy transfer is influenced by dynamic processes such as cloud cover, atmospheric gases, and Earth's rotation, as well as static conditions such as the positions of mountain ranges and of oceans, seas, and lakes. | **ESS-H-A1** investigating the methods of energy transfer and identifying the Sun as the major source of energy for most of Earth's systems<br>**ESS-H-A2** modeling the seasonal changes in the relative position and appearance of the Sun and inferring the consequences with respect to Earth's temperature<br>**ESS-H-A5** demonstrating how the Sun's radiant energy causes convection currents within the atmosphere and the oceans<br>**GLE HS EarthSci.1** Describe what happens to the solar energy received by Earth every day<br>**GLE HS EarthSci.2** Trace the flow of heat energy through the processes in the water cycle<br>**GLE HS EarthSci.3** Describe the effect of natural insulation on energy transfer in a closed system<br>**GLE HS EarthSci.4** Describe the relationship between seasonal changes in the angle of incoming solar radiation and its consequences to Earth's temperature (e.g., direct vs. slanted rays)<br>**GLE HS EarthSci.7** Analyze how radiant heat from the Sun is absorbed and transmitted by several different earth materials<br>**GLE HS EarthSci.8** Explain why weather only occurs in the tropospheric layer of Earth's atmosphere | 2 | IC<br>MC | ESS-H-A1 matches the first sentence of the NAEP standard |

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Earth and space science | | | | | |
| EARTH SYSTEMS | ***Biogeochemical cycles:*** *biogeochemical cycles in Earth systems* | | | | |
| | **E12.11:** Earth is a system containing essentially a fixed amount of each stable chemical atom or element. Most elements can exist in several different chemical forms. Earth elements move within and between the lithosphere, atmosphere, hydrosphere, and biosphere as part of biogeochemical cycles. | **ESS-H-B1** illustrating how stable chemical atoms or elements are recycled through the solid earth, oceans, atmosphere, and organisms<br>**ESS-H-B2** demonstrating Earth's internal and external energy sources as forces in moving chemical atoms or elements<br>**GLE HS EarthSci.13** Explain how stable elements and atoms are recycled during natural geologic processes<br>**GLE HS EarthSci.14** Compare the conditions of mineral formation with weathering resistance at Earth's surface<br>**GLE HS EarthSci.15** Identify the sun-driven processes that move substances at or near Earth's surface | 3 | | |
| | **E12.12:** Movement of matter through Earth's systems is driven by Earth's internal and external sources of energy. These movements are often accompanied by a change in the physical and chemical properties of the matter. Carbon, for example, occurs in carbonate rocks such as limestone, in coal and other fossil fuels, in the atmosphere as carbon dioxide gas, in water as dissolved carbon dioxide, and in all organisms as complex molecules that control the chemistry of life. | **LS-H-D1** illustrating the biogeochemical cycles and explaining their importance<br>**GLE HS Bio.23** Illustrate the flow of carbon, nitrogen, and water through an ecosystem | 2 | | Illustrating biogeochemical cycles |

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TABLE E1 (CONTINUED)

**Alignment of National Assessment of Educational Progress grade 12 science and Louisiana grade 11 benchmarks and grade level expectations**

| NAEP science standards | | Louisiana content | Overall rating[a] | Code[b] | Notes |
|---|---|---|---|---|---|
| Earth and space science | | | | | |
| EARTH SYSTEMS | **E12.13:** Natural ecosystems provide an array of basic processes that affect humans. These processes include maintenance of the quality of the atmosphere, generation of soils, control of the hydrologic cycle, disposal of wastes, and recycling of nutrients. | **LS-H-D4** exploring how humans have impacted ecosystems and the need for societies to plan for the future<br>**SE-H-C1** evaluating the dynamic interaction of land, water, and air and its relationship to living things in maintaining a healthy environment<br>**SE-H-B3** recognizing that population size and geographic and economic factors result in the inequitable distribution of Earth's resources<br>**GLE HS Bio.27** Analyze positive and negative effects of human actions on ecosystems<br>**GLE EnvirSci.15** Identify the factors that cause the inequitable distribution of Earth's resources (e.g., politics, economics, climate)<br>**GLE EnvriSci.19** Determine the interrelationships of clean water, land, and air to the success of organisms in a given population | 3 | IC | |

a. Rating is based on a scale of 1 to 3, where 1 indicates that state standards do not address NAEP content statement, 2 that state standards partially address NAEP content statement, and 3 that state standards fully address or exceed NAEP content statement by targeted grade level.

b. Codes are IC (implied content), LG (content covered at a lower grade level), HG (content covered at a higher grade level), MC (more content), and MD (more detailed content). See appendix C for further information.

TABLE E2

**Louisiana grade 12 high school benchmarks not covered by National Assessment of Educational Progress grade 12 content**

| Content area | Louisiana grade 12 high school benchmarks |
|---|---|
| Science as inquiry | SI-H-A1, SI-H-A2, SI-H-A3, SI-H-A4, SI-H-A5, SI-H-A6, SI-H-A7<br>SI-H-B1, SI-H-B2, SI-H-B3, SI-H-B4, SI-H-B5 |
| Physical science | PS-H-A1, PS-H-C1, PS-H-D3, PS-H-D1, PS-H-D2, PS-H-D4<br>PS-H-E4, PS-H-G4 |
| Life science | LS-H-B4, LS-H-C5, LS-H-C6, LS-H-C7<br>LS-H-F1, LS-H-F2, LS-H-F3, LS-H-F4<br>LS-H-G1, LS-H-G2, LS-H-G3, LS-H-G4, LS-H-G5 |
| Earth and space science | ESS-H-C3, ESS-H-D6, ESS-H-D7 |
| Science and the environment | SE-H-C4, SE-H-B6 |
| Content Standards and Objectives—Biology I | Bio-CS-1.1<br>Bio-CS-6.1 |

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