Georgia Milestones Assessment System

ASSESSMENT GUIDE

Assessment Guide

Physical Science

Georgia Department of Education
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THE GEORGIA MILESTONES ASSESSMENT SYSTEM

The purpose of the Georgia Student Assessment Program is to measure student achievement of the state-adopted content standards and inform efforts to improve teaching and learning. Results of the assessment program are utilized to identify students failing to achieve mastery of content, to provide educators with feedback about instructional practice, and to assist school districts in identifying strengths and weaknesses in order to establish priorities in planning educational programs.

The State Board of Education is required by Georgia law (O.C.G.A. §20-2-281) to adopt assessments designed to measure student achievement relative to the knowledge and skills set forth in the state-adopted content standards. The Georgia Milestones Assessment System (Georgia Milestones) fulfills this requirement and, as a key component of Georgia's Student Assessment Program, is a comprehensive summative assessment program spanning grade 3 through high school. Georgia Milestones measures how well students have learned the knowledge and skills outlined in the state-adopted content standards in Language Arts, Mathematics, Science, and Social Studies. Students in grades 3–8 take an end-of-grade assessment in each content area, while high school students take an end-of-course assessment for each of the eight courses designated by the State Board of Education. In accordance with State Board Rule, Georgia Milestones end-of-course measures serve as the final exams for the specified high school courses.

The main purpose of Georgia Milestones is to inform efforts to improve student achievement by assessing student performance on the standards specific to each course or subject/grade tested. Specifically, Georgia Milestones is designed to provide students and their parents with critical information about the students' achievement and, importantly, their preparedness for the next educational level. The assessment system is a critical informant of the state's accountability measure, the College and Career Ready Performance Index (CCRPI), providing an important gauge about the quality of the educational services and opportunities provided throughout the state. The ultimate goal of Georgia's assessment and accountability system is to ensure that all students are provided the opportunity to engage with high-quality content standards, receive high-quality instruction predicated upon those standards, and are positioned to meet high academic expectations.

Features of the Georgia Milestones Assessment System include:

- open-ended (constructed-response) items in Language Arts and Mathematics (all grades and courses);
- a writing component (in response to passages read by students) at every grade level and course within the Language Arts assessment;
- norm-referenced items in all content areas and courses to complement the criterion-referenced information and to provide a national comparison; and
- a transition to online administration over time, with online administration considered the primary mode of administration and paper/pencil as a back-up until the transition is complete.

The primary mode of administration for the Georgia Milestones program is online, with the goal of completing the transition from paper/pencil within five years after the inaugural administration (i.e., the

2014–2015 school year). Paper/pencil test materials (such as Braille) will remain available for students with disabilities who may require them in order to access the assessment.

Georgia Milestones follows guiding principles to help ensure that the assessment system:

- is sufficiently challenging to ensure Georgia students are well positioned to compete with other students across the United States and internationally;
- is intentionally designed across grade levels to send a clear signal of student academic progress and preparedness for the next level, be it the next grade level, course, or college or career;
- is accessible to all students, including those with disabilities or limited English proficiency, at all achievement levels;
- supports and informs the state's educator effectiveness initiatives, ensuring items and forms are appropriately sensitive to quality instructional practices; and
- accelerates the transition to online administration, allowing—over time—for the inclusion of innovative technology-enhanced items.

Georgia Milestones End-of-Course (EOC) Assessments

As previously mentioned, Georgia law (§20-2-281) mandates that the State Board of Education adopt EOC assessments for core courses to be determined by the Board. These assessments serve as a student's final exam in the associated course. With educator input, and State Board approval, the Georgia Milestones EOC assessments measure student achievement in the following courses: Ninth Grade Literature and Composition, American Literature and Composition, Coordinate Algebra, Analytic Geometry, Physical Science, Biology, United States History, and Economics/Business/Free Enterprise.

Any student enrolled in and/or receiving credit for one of the abovementioned courses, regardless of grade level, is required to take the Georgia Milestones assessment upon completion of that course. This includes middle school students completing a course associated with a Georgia Milestones EOC assessment, regardless of whether they are receiving high school credit. Students enrolling from non-accredited programs are required to take and pass the Georgia Milestones EOC assessment prior to receiving credit for the course.

A student's final grade in the course will be calculated using the Georgia Milestones EOC assessment as follows (State Board Rule 160-4-2-.13):

- For students enrolled in grade 9 for the first time before July 1, 2011, the EOC assessment counts as 15% of the final grade.
- For students enrolled in grade 9 for the first time on or after July 1, 2011, the EOC assessment counts as 20% of the final grade.

Results of the EOC assessments, according to the legislated and identified purposes, must:

- provide a valid measure of student achievement of the state content standards across the full achievement continuum;
- serve as the final exam for each course, contributing 20% to the student's final course grade;

- provide a clear signal of each student's preparedness for the next course and ultimately post-secondary endeavors (college and career);
- allow for the detection of the academic progress made by each student from one assessed course to the next;
- support and inform educator effectiveness measures; and
- inform state and federal accountability measures at the school, district, and state levels.

Additional uses of the EOC assessments include: (1) certifying student proficiency prior to the awarding of credit for students enrolling from non-accredited private schools, home study programs, or other non-traditional educational centers and (2) allowing eligible students to demonstrate competency without taking the course and earn course credit (e.g., "test out"). In both cases, students are allotted *one* administration.

Assessment Guide

The Georgia Milestones Physical Science EOC Assessment Guide is provided to acquaint Georgia educators and other stakeholders with the structure and content assessed by the test. Importantly, this guide is not intended to inform instructional planning. It is essential to note that there are a small number of content standards that are better suited for classroom or individual assessment rather than large-scale summative assessment. While those standards are not included in the tests, and therefore are not included in this Assessment Guide, the knowledge, concepts, and skills inherent in those standards are often required for the mastery of the standards that are assessed. Failure to attend to all content standards within a course can limit a student's opportunity to learn and show what he or she knows and can do on the assessment.

The Georgia Milestones Physical Science EOC Assessment Guide is in *no way* intended to substitute for the state-mandated content standards; it is provided to help educators better understand the structure and content of the assessment, *but it is not all-encompassing of the knowledge, concepts, and skills covered in the course or assessed on the test*. The state-adopted content standards and associated standards-based instructional resources, such as the Content Frameworks, should be used to plan instruction. This Assessment Guide can serve as a *supplement* to those resources, in addition to any locally developed resources, ***but should not be used in isolation***. In principle, the Assessment Guide is intended to be descriptive of the assessment program and should not be considered all-inclusive. The state-adopted content standards are located at www.georgiastandards.org.

TESTING SCHEDULE

The Georgia Milestones Physical Science EOC assessment is offered during three Main Administrations. Main Administrations are primarily intended to provide an opportunity to assess student achievement at the completion of a course and to serve as the final exam for the associated course as required by State Board Rule. As a result, the EOC assessment should occur as close to the conclusion of the course as possible. Main Administrations can also be utilized to verify credit from a non-accredited school or

home schooling. In addition to the Main Administrations, Mid-Month Administrations are provided in order to allow students additional testing opportunities for the various reasons noted below.

Purpose for EOC Assessment	Winter & Spring Main Administrations	Mid-Month Administrations	Summer Main Administration
Completion of Course	Yes	Yes	Yes
Makeup from Previous Administration	Yes	Yes	Yes
Retest	No*	Yes	Yes
Test Out	No	Yes, but only during specified windows	Yes
Validation of Credit	Yes	Yes	Yes

***Winter and Spring Main Administrations cannot be used for the purpose of a retest. There will be no retest administrations during the 2014–2015 school year.

Note: Each district determines a local testing window within the state-designated testing window.

TEST STRUCTURE

Description of Test Format and Organization

The Georgia Milestones Physical Science EOC assessment is primarily a criterion-referenced test designed to provide information about how well a student has mastered the state-adopted content standards that comprise the course. Each student will receive one of four proficiency levels, depending on how well the student has mastered the course content standards. In addition to criterion-referenced information, the Georgia Milestones measures will also include a limited sample of nationally norm-referenced items to provide a signal of how Georgia students are achieving relative to their peers nationally. The norm-referenced information provided is supplementary to the criterion-referenced proficiency designation and will not be utilized in any manner other than to serve as a barometer of national comparison. Only the criterion-referenced scores and proficiency designations will be utilized in the accountability metrics associated with the assessment program (such as student course grades, student growth measures, educator effectiveness measures, and the CCRPI).

The Physical Science EOC assessment consists of a total of 75 selected-response items, 67 of which are operational items (and contribute to a student's criterion-referenced and/or norm-referenced score) and 8 of which are field test items (newly written items that are being tried out and do not contribute to the student's scores). The criterion-referenced score, and proficiency designation, is comprised of 55 items, for a total of 55 points. Of the 67 operational items, 20 will be norm-referenced and will provide a national comparison in the form of a national percentile rank. Eight of the items have been verified as

aligned to the course content standards by Georgia educators and will therefore contribute to the criterion-referenced proficiency designation. The other 12 items will contribute only to the national percentile rank and be provided as supplemental information. Only items that are aligned to the state-adopted content standards will be utilized to inform the criterion-referenced score.

With the inclusion of the norm-referenced items, students may encounter items for which they have not received direct instruction. These items will not contribute to the student's criterion-referenced proficiency designation; only items that align to the course content standards will contribute to the criterion-referenced score. Students should be instructed to try their best should they ask about an item that is not aligned to the content they have learned as part of the course.

Physical Science EOC Assessment Design

Description	Number of Items	Points for CR[1] Score	Points for NRT[2] Feedback
CR Selected-Response Items	47	47	0
NRT Selected-Response Items	20[3]	8[4]	20
CR Field Test Items	8	0	0
Total Items/Points[5]	**75**	**55**	**20**

[1]CR—Criterion-Referenced: items aligned to state-adopted content standards
[2]NRT—Norm-Referenced Test: items that will yield a national comparison; may or may not be aligned to state-adopted content standards
[3]Of these items, 8 will contribute to both the CR scores and NRT feedback. The other 12 of these items will contribute to NRT feedback only and will not impact the student's proficiency designation, scale score, or grade conversion.
[4]Alignment of national NRT items to course content standards was verified by a committee of Georgia educators. Only approved, aligned NRT items will contribute to a student's CRT proficiency designation, scale score, and grade conversion score.
[5]Total number of items contributing to CR score: 55; total points: 55; total number of items contributing to NRT feedback: 20; total points: 20

The test will be given in two sections. Students may have up to 70 minutes, per section, to complete Sections 1 and 2. The total estimated testing time for the Physical Science EOC ranges from approximately 100 to 140 minutes. Total testing time describes the amount of time students have to complete the assessment. It does not take into account the time required for the test examiner to complete pre-administration and post-administration activities (such as reading the standardized directions to students). Sections 1 and 2 may be administered on the same day or across two consecutive days based on the district's testing protocols for the EOC measures (in keeping with state guidance).

During the Physical Science assessment, a reference sheet will be available for students to use. There is an example of the reference sheet in the Additional Sample Items section of this guide. Another feature of the Physical Science assessment is that students may use a scientific calculator throughout all sections of the test.

Content Measured

The Physical Science EOC assessment will assess the standards that are enumerated for the Physical Science course as described on www.georgiastandards.org.

The content of the assessment is organized into four groupings, or domains, of standards for the purposes of providing feedback on student performance. A content domain is a reporting category that *broadly* describes and defines the content of the course, as measured by the EOC assessment. The standards for Physical Science are grouped into four domains: Chemistry: Atomic and Nuclear Theory and the Periodic Table; Chemistry: Chemical Reactions and Properties of Matter; Physics: Energy, Force, and Motion; and Physics: Waves, Electricity, and Magnetism. Each domain was created by organizing standards that share similar content characteristics. The content standards describe the level of expertise that Physical Science educators should strive to develop in their students. Educators should refer to the content standards for a full understanding of the knowledge, concepts, and skills subject to be assessed on the EOC assessment.

The approximate proportional number of points associated with each domain is shown in the following table. A range of cognitive levels will be represented on the Physical Science EOC assessment. Educators should always use the content standards when planning instruction.

Physical Science: Domain Structures and Content Weights

Domain	Standard	Approximate Weight
Chemistry: Atomic and Nuclear Theory and the Periodic Table	SPS1 (1a, 1b) SPS3 (3a, 3b, 3c, 3d) SPS4 (4a, 4b) SPS5 (5a, 5b)	25%
Chemistry: Chemical Reactions and Properties of Matter	SPS2 (2a, 2b, 2c, 2d, 2e) SPS6 (6a, 6b, 6c, 6d, 6e)	25%
Physics: Energy, Force, and Motion	SPS7 (7a, 7b, 7c, 7d) SPS8 (8a, 8b, 8c, 8d, 8e)	25%
Physics: Waves, Electricity, and Magnetism	SPS9 (9a, 9b, 9c, 9d, 9e, 9f) SPS10 (10a, 10b, 10c)	25%

Item Types

The Physical Science EOC assessment consists of selected-response items only.

A selected-response item, sometimes called a multiple-choice item, is defined as a question, problem, or statement that appears on a test followed by several answer choices, sometimes called options or response choices. The incorrect choices, called distractors, usually reflect common errors. The student's task is to choose, from the alternatives provided, the best answer to the question posed in the stem (the question). The Physical Science selected-response items will have four answer choices.

Depth of Knowledge Descriptors

Items found on the Georgia Milestones assessments, including the Physical Science EOC assessment, are developed with a particular emphasis on cognitive complexity or Depth of Knowledge (DOK). DOK is measured on a scale of 1 to 4 and refers to the level of cognitive demand required to complete a task (or in this case, an assessment item). The higher the level, the more *complex* the item; however, higher levels do not necessarily mean *more difficult* items. For instance, a question can have a low DOK but a medium or even high difficulty level. Conversely, a DOK 4 question may have a low difficulty level but still require a great deal of cognitive thinking (e.g., analyzing and synthesizing information instead of just recalling it). The following descriptions and table show the expectations of the four DOK levels in greater detail.

Level 1 (Recall of Information) generally requires students to identify, list, or define, often asking them to recall who, what, when, and where. Consequently, this level usually asks students to recall facts, terms, concepts, and trends and may ask them to identify specific information contained in documents, excerpts, quotations, maps, charts, tables, graphs, or illustrations. Items that require students to "describe" and/or "explain" could be classified at Level 1 or Level 2 depending on what is to be described and/or explained. A Level 1 "describe" and/or "explain" would require students to recall, recite, or reproduce information.

Level 2 (Basic Reasoning) includes the engagement of some mental processing beyond recalling or reproducing a response. A Level 2 "describe" and/or "explain" would require students to go beyond a description or explanation of recalled information to describe and/or explain a result or "how" or "why."

Level 3 (Complex Reasoning) requires reasoning, using evidence, and thinking on a higher and more abstract level than Level 1 and Level 2. Students will go beyond explaining or describing "how and why" to justifying the "how and why" through application and evidence. Level 3 questions often involve making connections across time and place to explain a concept or "big idea."

Level 4 (Extended Reasoning) requires the complex reasoning of Level 3 with the addition of planning, investigating, applying significant conceptual understanding, and/or developing that will most likely require an extended period of time. Students should be required to connect and relate ideas and concepts *within* the content area or *among* content areas in order to be at this highest level. The

distinguishing factor for Level 4 would be a show of evidence, through a task, a product, or an extended response, that the cognitive demands have been met.

Many on-demand assessment instruments will not include assessment activities that could be classified as Level 4. However, standards, goals, and objectives can be stated so as to expect students to perform at this thinking level. The items on the Physical Science test will be written to DOK levels 1, 2, and 3.

The following table identifies skills that students will need to demonstrate at each DOK level, along with question cues appropriate for each level.

Level	Skills Demonstrated	Question Cues
Level 1 **Recall of Information**	• Make observations • Recall information • Recognize formulas, properties, patterns, processes • Know vocabulary, definitions • Know basic concepts • Perform one-step processes • Translate from one representation to another • Identify relationships	• Tell what, when, or where • Find • List • Define • Identify; label; name • Choose; select • Compute; estimate • Express • Read from data displays • Order
Level 2 **Basic Reasoning**	• Apply learned information to abstract and real life situations • Use methods, concepts, theories in abstract and real-life situations • Perform multi-step processes • Solve problems using required skills or knowledge (requires more than habitual response) • Make a decision about how to proceed • Identify and organize components of a whole • Extend patterns • Identify/describe cause and effect • Recognize unstated assumptions, make inferences • Interpret facts • Compare or contrast simple concepts/ideas	• Apply • Calculate; solve • Complete • Describe • Explain how; demonstrate • Construct data displays • Construct; draw • Analyze • Extend • Connect • Classify • Arrange • Compare; contrast
Level 3 **Complex Reasoning**	• Solve an open-ended problem with more than one correct answer • Create a pattern • Generalize from given facts	• Plan; prepare • Predict • Create; design • Ask “what if?” questions • Generalize

Level	Skills Demonstrated	Question Cues
Level 3 **Complex Reasoning –** **continued**	• Relate knowledge from several sources • Draw conclusions • Make predictions • Translate knowledge into new contexts • Compare and discriminate between ideas • Assess value of methods, concepts, theories, processes, formulas • Make choices based on a reasoned argument • Verify the value of evidence, information, numbers, data	• Justify; explain why; support; convince • Assess • Rank; grade • Test; judge • Recommend • Select • Conclude
Level 4 **Extended Reasoning**	• Analyze and synthesize information from multiple sources • Examine and explain alternative perspectives across a variety of sources • Apply mathematical models to illuminate a problem or situation • Design a mathematical model to inform and solve a practical or abstract situation • Combine and synthesize ideas into new concepts	• Design • Connect • Synthesize • Apply concepts • Critique • Analyze • Create • Prove

SCORES

Selected-response items are machine scored. The Physical Science EOC assessment consists of only selected-response items.

Students will receive an EOC scale score, an achievement level, a number correct out of the number possible, and a grade conversion score based on the items aligned to the state content standards. From the 20 embedded norm-referenced items, students will also receive scores that allow comparison to a national group of students.

EXAMPLE ITEMS

Example items, which are representative of the DOK levels across various Physical Science content domains, are provided on the following pages. **All example and sample items contained in this guide are the property of the Georgia Department of Education.**

Example Item 1

DOK Level: 1

Physical Science Domain: Physics: Waves, Electricity, and Magnetism

Standard: SPS9d. Investigate the phenomena of reflection, refraction, interference, and diffraction.

How are light waves affected when they pass from one medium into a more optically dense medium at an angle different from the normal?

A The light waves bend toward the normal.
B The light waves bend away from the normal.
C The light waves continue in a straight line at constant speed.
D The light waves continue in a straight line at an accelerating speed.

Correct Answer: A

Explanation of Correct Answer: The correct answer is choice (A) The light waves bend toward the normal. Light waves that move into a more optically dense medium decrease in speed, causing the waves to bend toward the normal. Choice (B) is incorrect because light waves bend away from the normal when they pass into a less optically dense medium. Choices (C) and (D) are incorrect because light waves change direction when entering a new medium at any angle other than the normal.

Example Item 2

DOK Level: 2

Physical Science Domain: Physics: Energy, Force, and Motion

Standard: SPS7a. Identify energy transformations within a system (e.g. lighting of a match).

Which of the following describes the conversion of chemical energy to heat energy?

A a chair sitting still
B a leaf absorbing sunlight
C a battery powering a flashlight
D a rock hitting the ground

Correct Answer: C

Explanation of Correct Answer: The correct answer is choice (C) a battery powering a flashlight. A battery is a source of chemical energy. In a flashlight, the battery's chemical energy is converted to light and heat. Choice (A) is incorrect because it does not describe a type of energy conversion. Choice (B) is incorrect because the leaf is converting light and heat energy from sunlight into chemical energy through photosynthesis. Choice (D) is incorrect because the rock's mechanical energy changes to non-mechanical energy when it hits the ground.

Example Item 3

DOK Level: 2

Physical Science Domain: Physics: Energy, Force, and Motion

Standard: SPS7b. Investigate molecular motion as it relates to thermal energy changes in terms of conduction, convection, and radiation.

Which statement correctly compares the difference between conduction and convection in common classroom settings?

A Conduction can only occur in solids, while convection can occur in both liquids and gases.
B Convection can only occur in solids, while conduction can occur in both liquids and gases.
C Conduction can only occur in liquids and gases, while convection can occur in solids, liquids, and gases.
D Convection can only occur in liquids and gases, while conduction can occur in solids, liquids, and gases.

Correct Answer: D

Explanation of Correct Answer: The correct answer is choice (D) Convection can only occur in liquids and gases, while conduction can occur in solids, liquids, and gases. Conduction happens between two substances in direct contact with each other: vibrating particles in one substance transfer their energy to particles in the other substance. Convection involves the movement of a heated liquid or gas: as the particles absorb energy they rise, and as they lose energy they sink. Choices (A), (B), and (C) are incorrect because conduction can happen in solids, liquids, and gases, whereas convection can happen only in fluids.

Example Item 4

DOK Level: 3

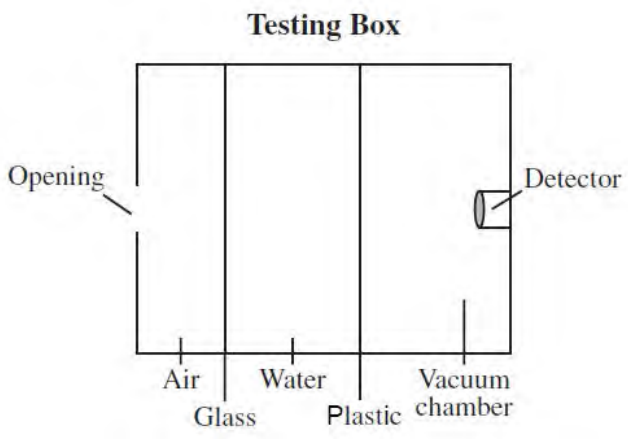
Physical Science Domain: Physics: Waves, Electricity, and Magnetism

Standard: SPS9c. Compare and contrast the characteristics of electromagnetic and mechanical (sound) waves.

This table shows four wave sources.

Source
Green laser
Tuning fork
UV lamp
Megaphone

The waves enter the testing box through the opening. Inside the testing box are three sections. The air and water sections are separated by a transparent glass pane. The water section and the vacuum chamber are separated by a transparent plastic pane.



Which sources will be detected?

A green laser and UV lamp
B UV lamp and megaphone
C green laser and tuning fork
D tuning fork and megaphone

Correct Answer: A

Explanation of Correct Answer: The correct answer is choice (A) green laser and UV lamp. Lasers and UV lamps emit electromagnetic waves, which can pass through all three mediums in the testing box: air, water, and a vacuum. Choices (B), (C), and (D) are incorrect because megaphones and tuning forks give off sound waves, and sound waves cannot travel through a vacuum.

Example Item 5

DOK Level: 3

Physical Science Domain: Chemistry: Chemical Reactions and Properties of Matter

Standard: SPS6b. Observe factors affecting the rate a solute dissolves in a specific solvent.

Four students each prepare a cup of coffee. The students use similar amounts of brewed coffee, sugar, and cold milk. This table describes each student's method of dissolving the sugar in the coffee.

	Coffee
Student 1	Adds sugar to hot coffee; then adds cold milk
Student 2	Adds sugar to hot coffee and stirs; then adds cold milk
Student 3	Adds cold milk to hot coffee; then adds sugar
Student 4	Adds cold milk to hot coffee; then adds sugar and stirs

Which student uses the method that will dissolve the sugar in the coffee the fastest?

A Student 1
B Student 2
C Student 3
D Student 4

Correct Answer: B

Explanation of Correct Answer: The correct answer is choice (B). Sugar will dissolve more quickly in a hotter liquid than in a liquid that has been cooled. Additionally, stirring sugar into a liquid will increase the rate at which the sugar dissolves. Choice (A) is incorrect because stirring the coffee (as student 2 does) would cause the sugar to dissolve more quickly. Choices (C) and (D) are incorrect because adding the cold milk first will cool the coffee.

ADDITIONAL SAMPLE ITEMS

This section has two parts. The first part is a set of 10 sample items for Physical Science. The second part contains a table that shows for each item the standard assessed, the DOK level, the correct answer (key), and a rationale/explanation about the key and distractors. The sample items can be utilized as a mini-test to familiarize students with the item formats found on the assessment. **All example and sample items contained in this guide are the property of the Georgia Department of Education.**

Physical Science Reference Sheet

Formulas

Force, Mass and Motion

Velocity = $\frac{\text{displacement}}{\text{time}}$ $(v = \frac{d}{t})$

Acceleration = $\frac{\textbf{final velocity} - \textbf{initial velocity}}{\text{time}}$ $(a = \frac{v_f - v_i}{t})$

Weight = mass × acceleration of gravity $(w = mg)$

Force = mass × acceleration $(F = ma)$

Work = force × distance $(W = Fd)$

Mechanical advantage =

$\frac{\text{effort distance}}{\text{resistance distance}} = \frac{\text{resistance force}}{\text{effort force}}$ $(MA = \frac{d_e}{d_r} = \frac{f_r}{f_e})$

Chemical Reactions and Properties of Matter

Density = $\frac{\text{mass}}{\text{volume}}$ $(D = \frac{m}{V})$

Volume of a rectangular solid = length × width × height $(V = lwh)$

Heat lost or gained =
mass × **specific heat capacity** × change in temperature $(Q = mc\Delta T)$

Waves, Electricity and Magnetism

Voltage = current × resistance $(V = IR)$

Georgia Milestones Assessment System

Constants and Relationships

Kelvin = °Celsius + 273 (K = °C + 273)

newton: 1 N = 1 kg • $\frac{m}{s^2}$

Acceleration due to gravity: g ≈ 10 $\frac{m}{s^2}$

joule: 1 J = 1 N • m

Georgia Milestones End of Course (EOC) Physical Science

Periodic Table

Key

Atomic number	29
Element symbol	Cu
Element name	Copper
Average atomic mass	63.55

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H Hydrogen 1.01																	2 He Helium 4.00
3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31											13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29
55 Cs Cesium 132.91	56 Ba Barium 137.33	57-71 ☆	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	89-103 ☆☆	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (269)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (272)	112 Cn Copernicium (285)	113 Uut Ununtrium (284)	114 Fl Flerovium (289)	115 Uup Ununpentium (288)	116 Lv Livermorium (293)	117 Uus Ununseptium (294)	118 Uuo Ununoctium (294)

☆ Lanthanide series	57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97
☆☆ Actinide series	89 Ac Actinium (227)	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

Item 1

Metals in group 1 on the periodic table most commonly form which type of ion?

A 2– ion
B 1– ion
C 1+ ion
D 2+ ion

Item 2

Use this chemical equation to answer the question.

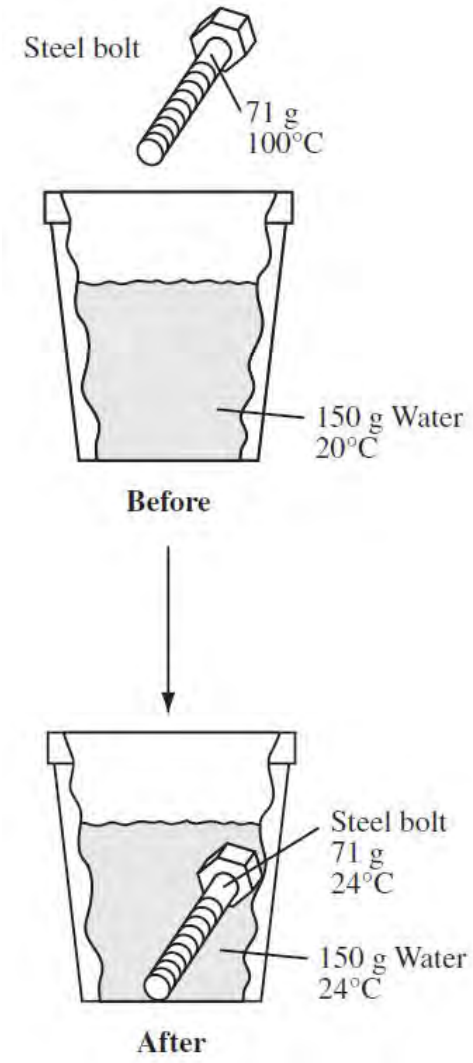
$\_CuS + \_KCl \rightarrow \_CuCl_2 + \_K_2S$

What coefficient of KCl will balance the equation?

A 1
B 2
C 3
D 4

Item 3

A hot (100°C) bolt with a mass of 71 grams is placed in 150 grams of cool (20°C) water. This diagram shows the resulting temperature changes. The specific heat of water is 4.186 J/g°C.



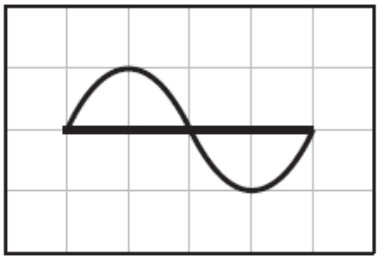
Approximately how many joules of heat does the water absorb?

A 2,512 J
B 3,700 J
C 15,070 J
D 22,590 J

Item 4

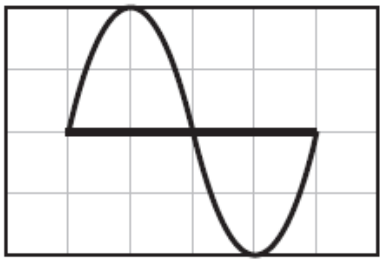
This diagram shows the wavelength and amplitude of Wave P.

Wave P

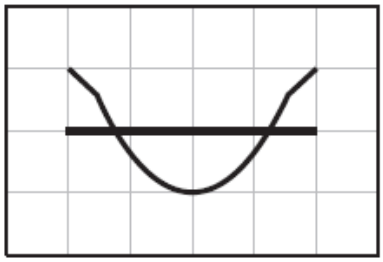


Which diagram shows the wavelength and amplitude required to cancel Wave P through destructive interference?

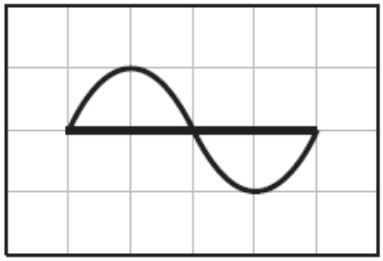
A



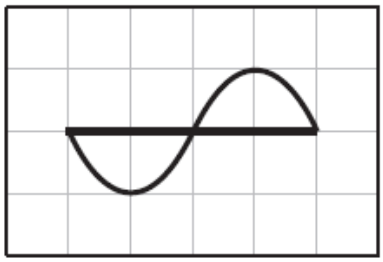
B



C



D



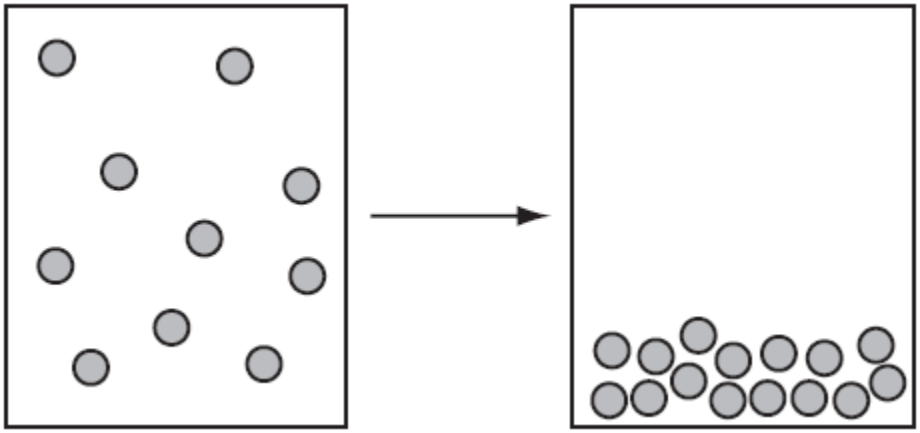
Item 5

A stable binary compound of Cl^{1-} and Mg^{2+} is sometimes prescribed by doctors to provide necessary magnesium to the human body. What is the chemical formula for this compound?

A MgCl
B Mg_2Cl
C $MgCl_2$
D Mg_2Cl_2

Item 6

The diagram shows matter changing state.



How did these particles move as matter changed state?

A The particles lost energy and moved more slowly.
B The particles lost energy and moved more quickly.
C The particles gained energy and moved more slowly.
D The particles gained energy and moved more quickly.

Item 7

The force of gravity on Mars is 0.38 times the gravity on Earth. The mass of an object on Earth is 71 kg.

What are the mass and weight of that object on Mars?

A mass: 71 kg, weight: 710 N
B mass: 71 kg, weight: 270 N
C mass: 27 kg, weight: 270 N
D mass: 27 kg, weight: 103 N

Item 8

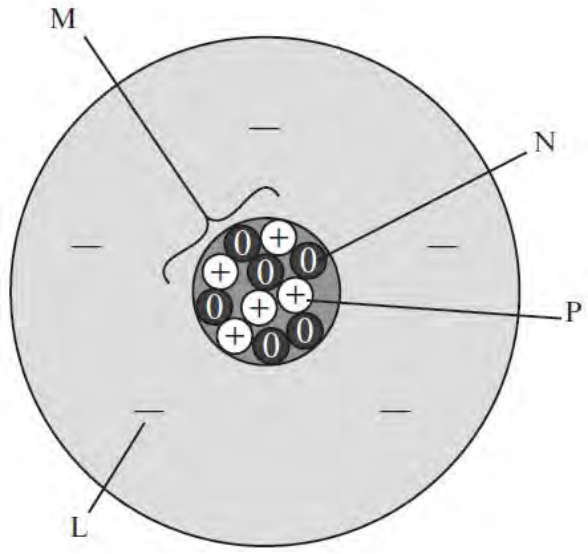
A negatively-charged ion always has more

A protons than neutrons
B neutrons than protons
C protons than electrons
D electrons than protons

Item 9

A scientist is measuring the mass of two boron (B) atoms. One atom has a mass of 10 units. The other atom has a mass of 11 units.

This is a model of a boron atom with a mass of 11 units.



Which subatomic particle needs to be removed from the model to represent a boron atom with a mass of 10 units?

A particle L
B particle M
C particle N
D particle P

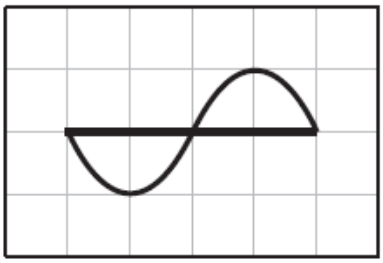
Item 10

Which statement describes how the majority of the energy received by Earth is transmitted by the Sun?

A Heated atoms emitted by the Sun move through space.
B Electromagnetic waves carry energy from the Sun through space.
C Heat energy from the Sun creates convection currents through space.
D Vibrating atoms in the Sun transfer heat energy to neighboring atoms in space.

Additional Sample Item Keys

Item	Standard/ Element	Characteristics of Science Standard/ Element	DOK Level	Correct Answer	Explanation
1	SPS4a	n/a	1	C	The correct answer is choice (C) 1+ ion. A metal in Group 1 has one valence election, which can easily be removed. When this happens, the resulting metal ion has one more proton than electron, giving it a 1+ charge. Choices (A) and (B) are incorrect because nonmetals typically form negatively charged ions. Choice (D) is incorrect because metals in Group 2 typically form ions with 2+ charges.
2	SPS2e	n/a	2	B	The correct answer is choice (B) 2. Two units of KCl combine with one unit of CuS to produce one unit of $CuCl_2$ and one unit of K_2S. Choices (A) and (C) are incorrect because the products contain an even number of potassium (K) ions; therefore, the reactants cannot have an odd number of potassium ions. Choice (D) is incorrect because the equation can be simplified by dividing each coefficient in half.
3	SPS7c	SCSh5e	2	A	The correct answer is choice (A) 2,512 J. To find the heat energy, in joules, that the water absorbs, multiply the water's specific heat (4.186 J/g°C) by the water's mass (150 g) by the change in temperature (4°C). The answer is 2,511.6 J, or approximately 2,512 J. Choices (B), (C), and (D) are incorrect because this calculation does not equal 3,700 J; 15,070 J; or 22,590 J.

Item	Standard/ Element	Characteristics of Science Standard/ Element	DOK Level	Correct Answer	Explanation
4	SPS9d	SCSh3d	2	D	The correct answer is choice (D)  . Destructive interference occurs between two waves in the same location: the crest of one wave meets the trough of the other wave. Because Wave P has the same amplitude as the wave in choice (D), the waves cancel each other out. Choices (A) and (C) are incorrect because these waves would overlap with Wave P, resulting in constructive interference. Choice (B) is incorrect because it does not show a wave with the same wavelength as Wave P; therefore, it cannot cancel Wave P through destructive interference.
5	SPS2b	n/a	2	C	The correct answer is choice (C) $MgCl_2$. The magnesium ion has a 2+ charge and two chloride ions, each with a charge of 1–, are required to balance the charges. Choices (A), (B), and (D) are incorrect because the charges do not balance to form a stable compound.
6	SPS5a	n/a	2	A	The correct answer is choice (A) The particles lost energy and moved more slowly. The diagram shows a gas, which consists of higher-energy particles moving quickly past each other, changing to a liquid, which consists of lower-energy particles moving more slowly past each other. Choices (B) and (C) are incorrect because particles that gain energy move more quickly, and particles that lose energy move more slowly. Choice (D) is incorrect because it describes how particles move when a liquid changes into a gas.

Item	Standard/ Element	Characteristics of Science Standard/ Element	DOK Level	Correct Answer	Explanation
7	SPS8b	SCSh5e	2	B	The correct answer is choice (B) mass: 71 kg, weight: 270 N. Mass is unaffected by gravity, so a 71-kg object on Earth would still be 71-kg on Mars. An object's weight equals its mass times the acceleration due to gravity (*g*), which on Earth is approximately 10 m/s^2. Therefore, on Mars *g* equals approximately 3.8 m/s^2, and the object would weigh 71 kg times 3.8 m/s^2, or approximately 270 N. Choice (A) is incorrect because this calculation does not equal 270 N. Choices (C) and (D) are incorrect because the object's mass would still equal 71 kg on Mars.
8	SPS1a	n/a	1	D	The correct answer is choice (D) electrons than protons. Electrons have negative charges, and protons have positive charges; the charge of one electron cancels the charge of one proton. Therefore, an ion with a negative charge must have more electrons than protons. Choices (A) and (B) are incorrect because neutrons are unrelated to an ion's charge. Choice (C) is incorrect because an ion with more protons than electrons has a positive charge.
9	SPS1a	n/a	2	C	The correct answer is choice (C) particle N. An atom's mass approximately equals the sum of its protons and neutrons. Particle N has zero charge, so it represents a neutron. Removing a neutron from the atom's nucleus would leave 5 protons and 5 neutrons, resulting in a boron atom with a mass of 10 units. Choice (A) is incorrect because particle L represents an electron, and electrons are too small to affect an atom's mass by an entire unit. Choice (B) is incorrect because M represents the atom's nucleus, which cannot be removed from the atom. Choice (D) is incorrect because particle P represents a proton; removing a proton would change the boron atom to a beryllium atom.

Item	Standard/ Element	Characteristics of Science Standard/ Element	DOK Level	Correct Answer	Explanation
10	SPS7b	n/a	2	B	The correct answer is choice (B) Electromagnetic waves carry energy from the Sun through space. The Sun gives off energy in the form of electromagnetic waves, which travel as radiation through the vacuum of space. Choices (C) and (D) are incorrect because space is a vacuum, and a vacuum does not contain atoms (which are required for convection). Choice (A) is incorrect because while some heated atoms are ejected by the sun, 95% of the energy comes to the earth in electromagnetic waves.