

*Adolescence and Young
Adulthood/Science*

**Component 1:
Content Knowledge**

**SAMPLE ITEMS
AND SCORING RUBRICS**

NATIONAL BOARD
for Professional Teaching Standards®

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AYA Science: Biology—Overview

This document provides information about the Adolescence and Young Adulthood Science: Biology (AYA/Science: Biology) Component 1 computer-based assessment. It includes sample assessment center selected response items and answer key, constructed response exercises, and the scoring rubric used to assess each constructed response exercise.

Component 1: Content Knowledge

Component 1: Content Knowledge is a computer-based assessment requiring candidates to demonstrate knowledge of and pedagogical practices for their teaching content area. Candidates must demonstrate knowledge of developmentally appropriate content, which is necessary for teaching across the full age range and ability level of the chosen certificate area.

AYA/Science: Biology Component 1 Computer-Based Assessment

In the AYA/Science: Biology Component 1 computer-based assessment, content knowledge is assessed through the completion of approximately 45 selected response items and three constructed response exercises.

AYA/Science: Biology Standards Measured by Selected Response Items

The AYA/Science: Biology selected response items focus on the following Standards:

Standards Content	Approximate Percentage of Selected Response Item Section*
<p>Knowledge of Science Practices and Context (Standard II)</p> <ul style="list-style-type: none"> • Nature of Science • Understanding of Inquiry • Context of Science 	20%
<p>Knowledge of Science Content (Standard II)</p> <ul style="list-style-type: none"> • Earth and Space Science • Life Science • Physical Science–Chemistry • Physical Science–Physics 	60% (45% in specialty 15% from other disciplines)
<p>Curriculum, Instruction, and Learning Environment (Standards III, V)</p> <ul style="list-style-type: none"> • Crosscutting Principles • Assessing and addressing preconceptions • Safety 	20%

* These percentages are an approximation only.

For the complete AYA/Science: Biology Standards, refer to www.nbpts.org/certification/candidate-center/.

AYA/Science: Biology Constructed Response Exercises

The AYA/Science: Biology constructed response exercises assess the following:

- **Exercise 1: Data Analysis**
In this exercise, you will use your knowledge of science to read a description of a student-designed experiment, study a student collection of data, and analyze a student conclusion concerning the experiment. You will be asked to respond to one prompt.
- **Exercise 2: Contexts of Science**
In this exercise, you will use your knowledge of science to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society. You will be asked to respond to one prompt.
- **Exercise 3: Development of Scientific Concepts**
In this exercise, you will demonstrate your knowledge of scientific conceptual development by evaluating and describing a student’s conceptual understanding of scientific concepts, and by describing instruction that would help move the student toward the accepted understanding of the scientific concept. You will be asked to respond to one prompt.

Each constructed response exercise will be assessed using a scoring rubric. Each AYA/Science: Biology Component 1 scoring rubric is derived from the Science Standards and defines the levels of accomplished teaching that you must demonstrate.

You should read the rubric while preparing to take Component 1 to understand how the rubric guides assessors in evaluating your responses to the constructed response exercises.

Inside This Document

This document includes the following three sections: "[Sample Selected Response Items and Answer Key for AYA/Science: Biology Component 1](#)," "[Sample Constructed Response Exercises and Scoring Rubrics for AYA/Science: Biology Component 1](#)," and "[Reference Material for AYA/Science: Biology Component 1](#)."

Selected Response Section

This section includes the following:

- sample selected response items
- answer key

Constructed Response Section

This section includes the following:

- three sample constructed response exercises
- associated scoring rubric for each exercise

Reference Material Section

This section includes the following about resources provided as part of the assessment:

- calculator information
- periodic table

Other Important Information

Refer to the National Board website for the following:

- For information about scheduling and taking your test at the assessment center, please refer to the *Assessment Center Policy and Guidelines*.
- For a link to an online tutorial, please refer to the *Assessment Center Testing* page.
- For more information about how the assessment is scored, please refer to the *Scoring Guide*.

Sample Selected Response Items and Answer Key for AYA/Science: Biology Component 1

This section includes

- **sample selected response items** to help you become familiar with the content and format of the items on an actual computer-based assessment.

Although this section illustrates some of the types of items that appear on the assessment, note that these sample items do not necessarily define the content or difficulty of an entire actual assessment.

Please note that the selected response items cover the *entire* age range of the certificate. Be aware that you are expected to demonstrate knowledge of developmentally appropriate content across the full range of your certificate.

- an **answer key**.

Sample Selected Response Items

Standard II. Knowledge of Science (Practices and Context)

1. **Use the information below to answer the question that follows.**

An ornithologist is interested in the question of how birds that belong to closely related species partition resources in an area to avoid competition. The ornithologist chooses two species of woodpecker that are sympatric in an area. One species is somewhat larger than the other and has a larger beak. The ornithologist hypothesizes that differences in prey size is most important in preventing competition. The ornithologist collects and analyzes data to test the hypothesis, and finds that the hypothesis is partially confirmed, although several alternative hypotheses are suggested by the results.

The use of inductive reasoning was most important during which stage of this investigation?

- A. observing the morphological and behavioral differences between the two species of woodpecker
- B. formulating the hypothesis that prey size is most important in preventing competition
- C. identifying variables that might affect differences in prey size taken by each species of woodpecker
- D. collecting the data and interpreting the results to determine the validity of the hypothesis

Standard II. Knowledge of Science (Practices and Context)

2. A teacher prepares for a classroom scientific investigation and presents the hypothesis shown to the students.

If carbon dioxide concentration decreases in a pond, then photosynthesis in algae will decrease, as measured by oxygen production.

Which statement correctly identifies the variables for this investigation?

- A. The independent variable is carbon dioxide concentration, and the dependent variable is oxygen concentration.
- B. The independent variable is algae growth, and the dependent variable is oxygen concentration.
- C. The independent variable is oxygen concentration, and the dependent variable is carbon dioxide concentration.
- D. The independent variable is carbon dioxide concentration, and the dependent variable is algae growth.

Standard II. Knowledge of Science (Content)

3. Use the table below to answer the question that follows.

Concentration of Fluid in Regions of the Kidney (g/100ml)				
	Urea	Glucose	Amino Acids	Inorganic Salts
Glomerulus	0.30	0.10	0.05	0.90
Bowman's Capsule	0.30	0.10	0.05	0.90
Proximal Tubule	0.40	0.00	0.00	0.54
Collecting Duct	1.80	0.00	0.00	3.25

Based on the data in the chart, what can be concluded about the function of the parts of the kidney?

- A. The Bowman's capsule is primarily involved in the secretion of urea.
- B. The glomerulus is primarily involved in the reabsorption of amino acids.
- C. The proximal tubule is primarily involved in the reabsorption of glucose.
- D. The collecting duct is primarily involved in the secretion of inorganic salts.

Standard II. Knowledge of Science (Content)

4. A solid has a melting point of $1,440^{\circ}\text{C}$. It conducts heat and electricity, and it does not dissolve in water or organic solvents. Which type of bond is present in the solid?
- A. ionic
 - B. dipole
 - C. metallic
 - D. covalent

Standard III. Curriculum and Instruction

5. During a unit on cell transport, a teacher has students carry out a lab on the efficiency of diffusion in cells. Students prepare three "cells" by cutting potatoes into cubes of three sizes—1 cm, 2 cm, and 3 cm per side. The cubes are placed into an iodine solution, then cut open after 15 minutes. Students measure the distance that the iodine has traveled into each cube as 0.5 cm and conclude that all the "cells" are equally efficient. How should the teacher proceed to help students correct this misconception?
- A. repeating the investigation with a different starch-rich specimen plant, such as apples
 - B. rerunning the investigation using a different indicator such as phenolphthalein
 - C. requiring students to repeat the activity using millimeter, rather than centimeter, calibrations
 - D. having students calculate and compare surface area and volume ratios for each cube

Standard V. Learning Environment

6. Some materials must be treated in special ways after they are used in a biology lab. Which material is correctly paired with an acceptable treatment?
- A. Goggles and aprons should be laundered.
 - B. Cultured stocks and plates should be autoclaved.
 - C. Latex gloves used during dissection should be chemically treated.
 - D. Syringes and other sharps should be double-bagged prior to disposal in the trash.

Answer Key to Sample Selected Response Items

Item Number	Correct Response
1	B
2	A
3	C
4	C
5	D
6	B

Sample Constructed Response Exercises and Scoring Rubrics for AYA/Science: Biology Component 1

This section includes

- **sample constructed response exercises** to help you become familiar with the content and format of the exercises on an actual computer-based assessment. These exercises include instructions for using the computer, stimulus materials (if applicable), and prompts requiring responses.

Although this section illustrates some of the types of exercises that appear on the assessment, note that these sample exercises do not necessarily define the content or difficulty of the exercises on an actual assessment.

Please note these constructed response exercises cover the **entire** age range of the certificate. Be aware that you are expected to demonstrate knowledge of developmentally appropriate content across the full range of your certificate.

- **scoring rubrics** that are used by assessors in evaluating your responses to help you understand how your responses are assessed.

Sample Exercise 1 and Scoring Rubric

Sample Exercise 1

Standard II. Knowledge of Science / Standard IV. Assessment

Exercise 1: Data Analysis - Candidate Name		⌚ Time Remaining 29:31
Data Analysis		
<u>Introduction</u>		
In this exercise, you will use your knowledge of science to read a description of a student-designed experiment, study a student collection of data, and analyze a student conclusion concerning the experiment. You will be asked to respond to one prompt.		
<u>Criteria for Scoring</u>		
To satisfy the highest level of the scoring rubric, your response must provide clear, consistent, and convincing evidence of the following:		
<ul style="list-style-type: none">• an accurate identification of the components of the experiment;• an accurate identification of the errors found in the student work sample;• an accurate identification and a thorough discussion of possible sources of error in the experimental design;• an accurate identification and an informed discussion of errors in the correlation between the student hypothesis, conclusion, and collected data; and• an accurate discussion of the science content knowledge that is needed in order to understand an experiment.		
<u>Directions</u>		
You may view the prompt by clicking the Next button. Compose your response in the space provided.		
? <u>H</u> elp	⦿ <u>N</u> avigator	<u>N</u> ext →

Exercise 1: Data Analysis - Candidate Name

 **Time Remaining**
29:31

Below you will find a description of a student experiment, a hypothesis made by the students, a sample of student data, and a conclusion derived by the students following the experiment.

A group of biology students conducted an experiment to test the effects of temperature on the rate of iodine diffusion through a semipermeable membrane. The experiment was designed to model diffusion of medication through a cell membrane. Iodine, an indicator of the presence of starch, represented the medication. A starch solution modeled the targeted cell components, and dialysis tubing modeled the cell membrane.

The students tied the bottom of five 15 cm long pieces of dialysis tubing and filled each with 25.0 mL of the starch solution. Then they tied the tubing at the top. The students filled each of five beakers with the same amount of 25°C water and placed one piece of filled dialysis tubing into each beaker. The students added 10.0 mL of liquid iodine to each of the five beakers. Then the students timed how long it took for the starch solution inside of the dialysis tube to turn a blue-black color. The experiment was repeated with 0°C water and then with 75°C water in the beaker.

The students' hypothesis stated that the iodine in the 25°C water would move through the membrane at the fastest rate and turn the starch solution to a darker color because the molecules of iodine would be moving faster at the normal temperature and would have a greater likelihood of coming into contact with the tubing and moving through the tubing.

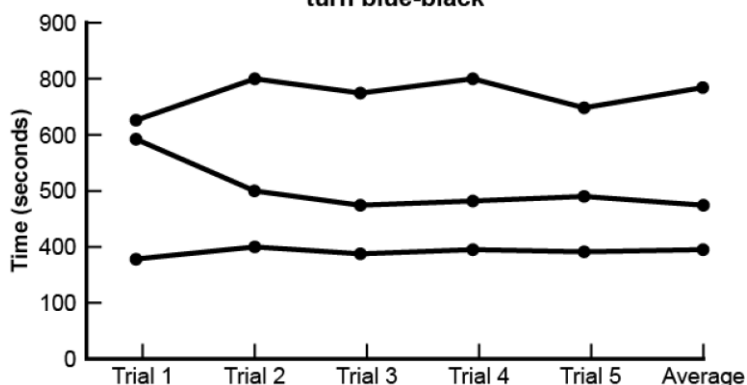
Exercise 1: Data Analysis - Candidate Name

 Time Remaining
29:31

Student data:

Time for Starch Solution to Turn Blue-black (seconds)						
Temperature of water in the beaker (°C)	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average
0	630	810	754	801	690	737
25	480	502	475	490	503	490
75	310	400	355	367	343	355

Temperature vs. time for solution to turn blue-black



The students concluded that the hottest solution of iodine and water diffused through the membrane the fastest with an average time of 355 seconds, while the coldest solution of iodine and water took the longest time to diffuse, with an average time of 737 seconds. The data did support the hypothesis. This could be a model for developing medicine to act on different cellular structures by changing the temperature of the medication solution so the medicine could be fast acting or slow acting.

You must address each of the following in your response.

- Identify the **control (if present)**, **controlled variable(s)**, the **experimental dependent variable**, and the **experimental independent variable**.
- Identify the **errors** found in the mechanics of the graph.
- Identify and thoroughly discuss the possible **sources of error** resulting from the experimental design.
- Identify and discuss **errors** in the correlation between the **hypothesis**, the **conclusion**, and the **collected data**.
- Discuss **two** concepts related to the movement of particles through a selectively permeable membrane that a **high school** student must know to understand this investigation.

? Help

⦿ Navigator

Next →

Scoring Rubric for Exercise 1

The **LEVEL 4** response provides *clear, consistent, and convincing* evidence of the ability to evaluate a student-designed experiment, identify the components of the experiment, and analyze a student conclusion concerning the experiment.

Characteristics:

- An accurate and thorough identification of the components of the experiment.
- An accurate and thorough identification of the errors found in a student work sample.
- An accurate identification and a thorough discussion of possible sources of error in an experimental design.
- An accurate and thorough identification and an informed discussion of errors in the correlation between the student hypothesis, conclusion, and collected data.
- An accurate and thorough discussion of the science content knowledge that is needed in order to understand the experiment.

The **LEVEL 3** response provides *clear* evidence of the ability to evaluate a student-designed experiment, identify the components of the experiment, and analyze a student conclusion concerning the experiment.

Characteristics:

- An accurate identification of the components of the experiment.
- An accurate identification of the errors found in a student work sample.
- An accurate identification and a discussion of possible sources of error in the experimental design, although the discussion may not be as thorough as a Level 4 response.
- An accurate identification and an informed discussion of errors in the correlation between the student hypothesis, conclusion, and collected data, but the discussion is not as informed as a Level 4 response.
- An accurate discussion of the science content knowledge that is needed in order to understand an experiment, although the discussion may not be as detailed as in a Level 4 response.

The **LEVEL 2** response provides *limited* evidence of the ability to evaluate a student-designed experiment, identify the components of the experiment, and analyze a student conclusion concerning the experiment.

Characteristics:

- An incomplete identification of the components of the experiment.
- An incomplete identification of the errors found in a student work sample.
- An incomplete identification or a limited discussion of possible sources of error in the experimental design.
- An accurate identification but the discussion of errors in the correlation between the student hypothesis, conclusion, and collected data may only be partially related to the student errors, or the identification of errors is incomplete or limited.
- A discussion of the science content knowledge that is needed in order to understand the experiment is limited.

The **LEVEL 1** response provides *little or no* evidence of the ability to evaluate a student-designed experiment, identify the components of an experiment, and analyze a student conclusion concerning the experiment.

Characteristics:


- An inaccurate or missing identification of the components of the experiment.
- An inaccurate or missing identification of the errors found in a student work sample.
- An inaccurate identification or missing discussion of possible sources of error in the experimental design.
- An inaccurate or missing identification and discussion of errors in the correlation between the student hypothesis, conclusion, and collected data.
- A discussion of the science content knowledge that is needed in order to understand the experiment is inaccurate or missing.

Sample Exercise 2 and Scoring Rubric

Sample Exercise 2

Standard II. Knowledge of Science / Standard III. Curriculum and Instruction

Exercise 2: Contexts of Science - Candidate Name		⌚ Time Remaining 29:31
Contexts of Science		
<u>Introduction</u>		
<p>In this exercise, you will use your knowledge of science to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society. You will be asked to respond to one prompt.</p>		
<u>Criteria for Scoring</u>		
<p>To satisfy the highest level of the scoring rubric, your response must provide clear, consistent, and convincing evidence of the following:</p>		
<ul style="list-style-type: none">• an accurate and informed description of a major scientific event or discovery;• a thorough and insightful discussion of the scientific knowledge necessary to understand the event or discovery;• an accurate and thorough explanation of how another science discipline is related to the event or discovery; and• an informed description of effects the event or discovery has had on society.		
<u>Directions</u>		
<p>You may view the prompt by clicking the Next button. Compose your response in the space provided.</p>		
? Help	⌚ Navigator	Next →

Exercise 2: Contexts of Science - Candidate Name		 Time Remaining 29:31
<p>The theme of hierarchical organization in biology has long been an area of study for aspiring biologists. Throughout time biologists have been interested in the structure and function of life. The development of technology has provided the ability to view, compare, and study the smallest part of living things.</p> <p>Robert Hooke's <i>Micrographia</i> inspired Anton van Leeuwenhoek to develop and improve the technology of that time. Van Leeuwenhoek studied plant and animal tissues, blood cells, minerals, and even fossils. Many consider Van Leeuwenhoek the "father of microscopy" because of his technology and studies of the unseen world. His devoted interest in studying the microcosms is the foundation for modern breakthroughs.</p>		
<p>You must address each of the following in your response.</p> <ul style="list-style-type: none">• Discuss the scientific event or discovery.• Discuss the science knowledge necessary to understand the event or discovery.• Explain how a science discipline other than biology is related to the event or discovery.• Describe two effects the event or discovery has had on society.		
? Help	⊙ Navigator	Next →

Scoring Rubric for Exercise 2

The **LEVEL 4** response provides *clear, consistent, and convincing* evidence of the ability to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society.

Characteristics:

- An accurate and thorough description of a major scientific event or discovery.
- A thorough and insightful discussion of the scientific knowledge necessary to understand the event or discovery.
- An accurate and thorough explanation of how another science discipline is related to the event or discovery.
- A thorough description of how the event or discovery has affected society.

The **LEVEL 3** response provides *clear* evidence of the ability to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society.

Characteristics:

- An accurate and informed description of a major scientific event or discovery.
- A thorough and complete discussion of the scientific knowledge necessary to understand the event or discovery, although the discussion may not be as thorough as a Level 4 response.
- An accurate and complete explanation of how another science discipline is related to the event or discovery, but the discussion is not as informed as a Level 4 response.
- An informed description of how the event or discovery has affected society, although the discussion may not be as detailed as in a Level 4 response.

The **LEVEL 2** response provides *limited* evidence of the ability to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society.

Characteristics:

- An incomplete description of a major scientific event or discovery.
- An incomplete discussion of the scientific knowledge necessary to understand the event or discovery.
- An incomplete explanation of how another science discipline is related to the event or discovery.
- An incomplete description of how the event or discovery has affected society.

The **LEVEL 1** response provides *little or no* evidence of the ability to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society.

Characteristics:


- An inaccurate or missing description of a major scientific event or discovery.
- An inaccurate or missing discussion of the scientific knowledge necessary to understand the event or discovery.
- An inaccurate or missing explanation of how another science discipline is related to the event or discovery.
- An inaccurate or missing description of how the event or discovery has affected society.

Sample Exercise 3 and Scoring Rubric

Sample Exercise 3

Standard II. Knowledge of Science / Standard III. Curriculum and Instruction /
Standard IV. Assessment

Exercise 3: Development of Scientific Concepts - Candidate Name		⌚ Time Remaining 29:31
Development of Scientific Concepts		
<u>Introduction</u>		
In this exercise, you will demonstrate your knowledge of scientific conceptual development by evaluating and describing a student's conceptual understanding of scientific concepts, and by describing instruction that would help move the student toward the accepted understanding of the scientific concept. You will be asked to respond to one prompt.		
<u>Criteria for Scoring</u>		
To satisfy the highest level of the scoring rubric, your response must provide clear, consistent, and convincing evidence of the following:		
<ul style="list-style-type: none">• an accurate evaluation of a student's conceptual understanding through examination of the student's work;• an accurate description of two scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding; and• an informed description of the instruction you would use to address the student's conceptual understanding.		
<u>Directions</u>		
You may view the prompt by clicking the Next button. Compose your response in the space provided.		
? Help	⌚ Navigator	Next →

Exercise 3: Development of Scientific Concepts -		 Time Remaining
Candidate Name		29:31
<p>The National Aeronautics and Space Administration (NASA) recently found that there may be water molecules on particles of interplanetary dust. In addition, scientists have found evidence of water underneath the surface of several moons of outer planets. A high school biology student was asked to use these findings to discuss the possibility of whether or not other life could exist outside of Earth.</p>		
<p style="text-align: center;">Student Response:</p> <p>If the temperature is between 0°C and 100°C, then life could exist if there is oxygen, enough room to live, and a food source. Just because we have not seen evidence of life outside of Earth yet, that does not mean that there is no life elsewhere. It could be microscopic in nature, and we may need to have greater resolution on our current telescopes and satellites to see it.</p>		
<p>You must address each of the following in your response.</p> <ul style="list-style-type: none">• Evaluate the student’s conceptual understanding.• Describe in detail two scientific concepts the student would need to understand in order to move toward the accepted scientific understanding of the concept.• Briefly describe what you would do next in an instructional context to address the student’s conceptual understanding.		
? Help	⦿ Navigator	Next →

Scoring Rubric for Exercise 3

The **LEVEL 4** response provides *clear, consistent, and convincing* evidence of the ability to identify and describe the student’s conceptual understanding of scientific concepts; and to describe how the student can be instructed in order to move toward the accepted understanding of the scientific concept.

Characteristics:

- An accurate and thorough identification of a student’s conceptual understanding through examination of the student’s work.
- An accurate and thorough description of two scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding.
- An informed and thorough description of the instruction you would use to address the student’s conceptual understanding.

The **LEVEL 3** response provides *clear* evidence of the ability to identify and describe the student’s conceptual understanding of scientific concepts; and to describe how the student can be instructed in order to move toward the accepted understanding of the scientific concept.

Characteristics:

- An accurate identification of a student’s conceptual understanding through examination of the student’s work.
- An accurate description of two scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding, although the description may not be as thorough as a Level 4 response.
- An informed description of the instruction you would use to address the student’s conceptual understanding, although the description may not be as thorough as a Level 4 response.

The **LEVEL 2** response provides *limited* evidence of the ability to identify and describe the student's conceptual understanding of scientific concepts; and to describe how the student can be instructed in order to move toward the accepted understanding of the scientific concept.

Characteristics:

- An incomplete identification of a student's conceptual understanding through examination of the student's work.
- An incomplete description of the scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding.
- An incomplete description of the instruction you would use to address the student's conceptual understanding.

The **LEVEL 1** response provides *little or no* evidence of the ability to identify and describe the student's conceptual understanding of scientific concepts; and to describe how the student can be instructed in order to move toward the accepted understanding of the scientific concept.

Characteristics:

- An inaccurate or missing identification of a student's conceptual understanding through examination of the student's work.
- An inaccurate or missing description of the scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding.
- An inaccurate or missing description of the instruction you would use to address the student's conceptual understanding.

Reference Material for AYA/Science: Biology Component 1

This section includes the following about resources provided as part of the assessment:

- information about the online scientific calculator
- periodic table

Calculator Information

An online scientific calculator is available to you for this test. It is similar to the Texas Instruments handheld TI-30XS scientific calculator.

To access the calculator, click on the calculator icon located in the upper left corner of the screen. A pop-up window containing the calculator will appear. You can reposition the calculator by placing your cursor in the blue area above the calculator and dragging the window to the location of your choice.

Use the numbers on the keyboard and/or point and click with the mouse to enter your computations into the on-screen calculator. When you are finished, close the calculator by clicking the button in the upper right corner of the calculator.

AYA Science: Chemistry—Overview

This document provides information about the Adolescence and Young Adulthood Science: Chemistry (AYA/Science: Chemistry) Component 1 computer-based assessment. It includes sample assessment center selected response items and answer key, constructed response exercises, and the scoring rubric used to assess each constructed response exercise.

Component 1: Content Knowledge

Component 1: Content Knowledge is a computer-based assessment requiring candidates to demonstrate knowledge of and pedagogical practices for their teaching content area. Candidates must demonstrate knowledge of developmentally appropriate content, which is necessary for teaching across the full age range and ability level of the chosen certificate area.

AYA/Science: Chemistry Component 1 Computer-Based Assessment

In the AYA/Science: Chemistry Component 1 computer-based assessment, content knowledge is assessed through the completion of approximately 45 selected response items and three constructed response exercises.

AYA/Science: Chemistry Standards Measured by Selected Response Items

AYA/Science: Chemistry selected response items focus on the following Standards:

Standards Content	Approximate Percentage of Selected Response Item Section*
<p>Knowledge of Science Practices and Context (Standard II)</p> <ul style="list-style-type: none"> • Nature of Science • Understanding of Inquiry • Context of Science 	<p>20%</p>
<p>Knowledge of Science Content (Standard II)</p> <ul style="list-style-type: none"> • Earth and Space Science • Life Science • Physical Science–Chemistry • Physical Science–Physics 	<p>60% (45% in specialty 15% from other disciplines)</p>
<p>Curriculum, Instruction, and Learning Environment (Standards III, V)</p> <ul style="list-style-type: none"> • Crosscutting Principles • Assessing and addressing preconceptions • Safety 	<p>20%</p>

* These percentages are an approximation only.

For the complete AYA/Science: Chemistry Standards, refer to www.nbpts.org/national-board-certification/candidate-center/.

AYA/Science: Chemistry Constructed Response Exercises

The AYA/Science: Chemistry constructed response exercises assess the following:

- **Exercise 1: Data Analysis**
In this exercise, you will use your knowledge of science to read a description of a student-designed experiment, study a student collection of data, and analyze a student conclusion concerning the experiment. You will be asked to respond to one prompt.
- **Exercise 2: Contexts of Science**
In this exercise, you will use your knowledge of science to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society. You will be asked to respond to one prompt.
- **Exercise 3: Development of Scientific Concepts**
In this exercise, you will demonstrate your knowledge of scientific conceptual development by evaluating and describing a student's conceptual understanding of scientific concepts, and by describing instruction that would help move the student toward the accepted understanding of the scientific concept. You will be asked to respond to one prompt.

Each constructed response exercise will be assessed using a scoring rubric. Each AYA/Science: Chemistry Component 1 scoring rubric is derived from the Science Standards and defines the levels of accomplished teaching that you must demonstrate.

You should read the rubric while preparing to take Component 1 to understand how the rubric guides assessors in evaluating your responses to the constructed response exercises.

Inside This Document

This document includes the following three sections: "[Sample Selected Response Items and Answer Key for AYA/Science: Chemistry Component 1](#)," "[Sample Constructed Response Exercises and Scoring Rubrics for AYA/Science: Chemistry Component 1](#)," and "[Reference Material for AYA/Science: Chemistry Component 1](#)."

Selected Response Section

This section includes the following:

- sample selected response items
- answer key

Constructed Response Section

This section includes the following:

- three sample constructed response exercises
- associated scoring rubric for each exercise

Reference Material Section

This section includes the following about resources provided as part of the assessment:

- calculator information
- constants
- periodic table

Other Important Information

Refer to the National Board website for the following:

- For information about scheduling and taking your test at the assessment center, please refer to the *Assessment Center Policy and Guidelines*.
- For a link to an online tutorial, please refer to the *Assessment Center Testing* page.
- For more information about how the assessment is scored, please refer to the *Scoring Guide*.

Sample Selected Response Items and Answer Key for AYA/Science: Chemistry Component 1

This section includes

- **sample selected response items** to help you become familiar with the content and format of the items on an actual computer-based assessment.

Although this section illustrates some of the types of items that appear on the assessment, note that these sample items do not necessarily define the content or difficulty of an entire actual assessment.

Please note that the selected response items cover the *entire* age range of the certificate. Be aware that you are expected to demonstrate knowledge of developmentally appropriate content across the full range of your certificate.

- an **answer key**.

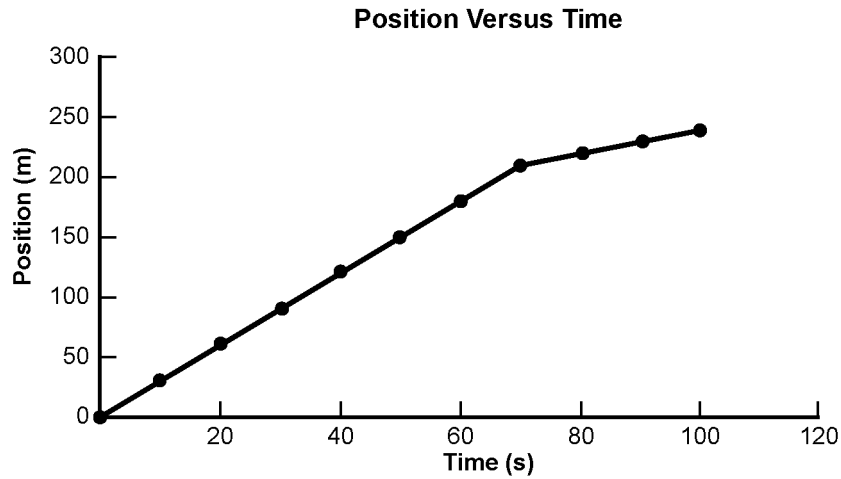
Sample Selected Response Items

Standard II. Knowledge of Science (Practices and Context)

1. A teacher gives students nine containers filled with solutions and each numbered one through nine. The teacher also provides a list of the nine compounds found in the nine containers. The students must use observational skills and their knowledge of chemical reactions to identify the compound in each container. The students are allowed to mix the solutions in microscale reaction wells. Two of the compounds in question are $\text{NaC}_2\text{H}_3\text{O}_2$ and HCl . When the students mix these two reagents, what are they most likely to observe?
 - A. a white precipitate
 - B. a distinct odor
 - C. a color change
 - D. a popping noise

Standard II. Knowledge of Science (Practices and Context)

2. An athlete jogs then walks to cool down before her race. A graph of the athlete's displacement is shown.



What is the average velocity of the athlete over the entire 100 seconds?

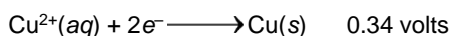
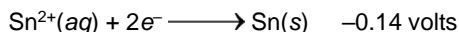
- A. 1.0 m/s
- B. 2.0 m/s
- C. 2.4 m/s
- D. 3.0 m/s

Standard II. Knowledge of Science (Content)

3. Meiosis is a reduction division that produces haploid daughter cells from diploid parent cells. Meiosis is important because it:
- A. constitutes the main process by which somatic cells are produced in multicellular organisms.
 - B. produces the maximum number of haploid daughter cells resulting in a greater number of offspring.
 - C. provides the mechanism for storing genetic information from unduplicated chromosomes as they become visible and compact.
 - D. increases the genetic diversity of the organism through the processes of independent assortment and crossing-over of the chromosomes.

Standard II. Knowledge of Science (Content)

4. A teacher demonstrates an electrochemical reaction. The teacher uses two beakers, a salt bridge, conductive wire, a solid tin electrode, a solid copper electrode, a 0.250 M tin(II) chloride (SnCl_2) solution, and a 0.250 M copper(II) sulfate (CuSO_4) solution.



Using the reduction potential values given, what results can the teacher expect from the demonstration?

- A. Solid tin will be plated out on the tin anode, and the concentration of Sn^{2+} will decrease.
- B. Solid tin will be plated out on the copper anode, and the concentration of Sn^{2+} will decrease.
- C. Solid copper will be plated out on the tin anode, and the concentration of Sn^{2+} will increase.
- D. Solid copper will be plated out on the copper cathode, and the concentration of Sn^{2+} will increase.

Standard III. Curriculum and Instruction

5. Students are separating the components of a mixture of iron filings, sand, and sodium chloride (NaCl). A bar magnet is used to remove the iron filings and then the sand-salt mixture is added to a beaker of hot water. The water solution is poured off and is then the water is allowed to evaporate in order to recover the NaCl . Which of the following student summary statements about the activity expresses a misconception associated with this investigation?

- A. Sodium chloride dissolves because water is a polar molecule.
- B. Dissolving is a physical change that does not require an input of energy.
- C. There is an increase in entropy when a solvent dissolves a solute.
- D. Ionic bonds are broken when sodium chloride is dissolved in water.

Standard V. Learning Environment

6. For safety reasons, some chemicals need to be used in a fume hood. Which property is characteristic of chemicals that should be used in a fume hood?

- A. low boiling point
- B. high flammability
- C. high melting point
- D. insolubility in water

Answer Key to Sample Selected Response Items

Item Number	Correct Response
1	B
2	C
3	D
4	D
5	B
6	A

Sample Constructed Response Exercises and Scoring Rubrics for AYA/Science: Chemistry Component 1

This section includes

- **sample constructed response exercises** to help you become familiar with the content and format of the exercises on an actual computer-based assessment. These exercises include instructions for using the computer, stimulus materials (if applicable), and prompts requiring responses.

Although this section illustrates some of the types of exercises that appear on the assessment, note that these sample exercises do not necessarily define the content or difficulty of the exercises on an actual assessment.

Please note these constructed response exercises cover the **entire** age range of the certificate. Be aware that you are expected to demonstrate knowledge of developmentally appropriate content across the full range of your certificate.

- **scoring rubrics** that are used by assessors in evaluating your responses to help you understand how your responses are assessed.

Sample Exercise 1 and Scoring Rubric

Sample Exercise 1

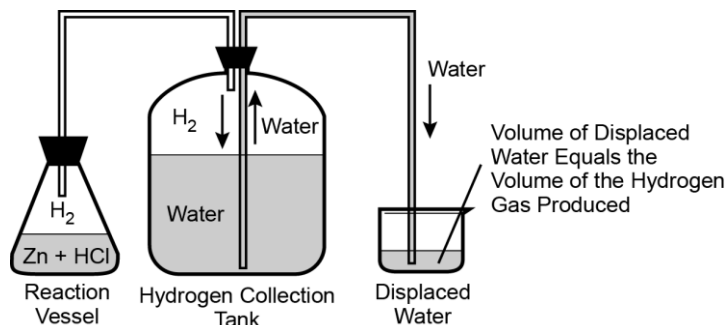
Standard II. Knowledge of Science / Standard IV. Assessment

Exercise 1: Data Analysis - Candidate Name		⌚ Time Remaining 29:31
Data Analysis		
<u>Introduction</u>		
In this exercise, you will use your knowledge of science to read a description of a student-designed experiment, study a student collection of data, and analyze a student conclusion concerning the experiment. You will be asked to respond to one prompt.		
<u>Criteria for Scoring</u>		
To satisfy the highest level of the scoring rubric, your response must provide clear, consistent, and convincing evidence of the following:		
<ul style="list-style-type: none">• an accurate identification of the components of the experiment;• an accurate identification of the errors found in the student work sample;• an accurate identification and a thorough discussion of possible sources of error in the experimental design;• an accurate identification and an informed discussion of errors in the correlation between the student hypothesis, conclusion, and collected data; and• an accurate discussion of the science content knowledge that is needed in order to understand an experiment.		
<u>Directions</u>		
You may view the prompt by clicking the Next button. Compose your response in the space provided.		
? <u>H</u> elp	⦿ <u>N</u> avigator	<u>N</u> ext →

Exercise 1: Data Analysis - Candidate Name

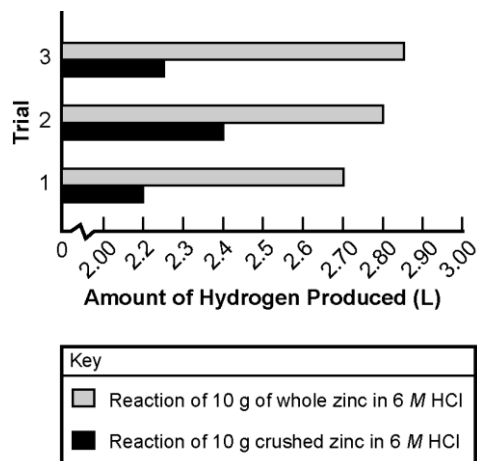
⌚ Time Remaining
 29:31

A student conducted an investigation to study a factor that can influence the rate of the reaction of zinc metal in hydrochloric acid. The student hypothesized that crushed zinc would produce more hydrogen gas than uncrushed zinc. To test this hypothesis, the student measured the volume of hydrogen gas (in liters) released when 10.0 g of crushed zinc and 10.0 g of uncrushed zinc reacted with 100 mL 6 M HCl for ten minutes. The experimental setup that the student used is illustrated below.



Reaction of 10.0 g Uncrushed Zinc in 6 M HCl	
Trial	Volume of hydrogen gas produced in L = Volume of water displaced
1	2.2
2	2.4
3	2.25

Reaction of 10.0 g Crushed Zinc in 6 M HCl	
Trial	Volume of hydrogen gas produced in L = Volume of water displaced
1	2.7
2	2.8
3	2.85



The student analyzed the graph with the data collected. Using the collected data from this experiment, the student concluded that crushed zinc reacts better and produces more hydrogen gas than uncrushed zinc. The student attributed this higher hydrogen gas yield to the ease of exposure of the crushed zinc particles to the hydrochloric acid.

You must address each of the following in your response.

- Identify the **controlled variable(s)/constant(s)**, the **experimental dependent variable**, and the **experimental independent variable**.
- Identify the **errors** found in the mechanics of the graph.
- Identify and thoroughly discuss the possible **sources of error** resulting from the experimental design.
- Identify and discuss **errors** in the correlation between the **hypothesis**, the **conclusion**, and the **collected data**.
- Discuss **two** concepts related to factors affecting chemical reactions that a **high school** chemistry student must know to understand this investigation.

? Help

⦿ Navigator

Next →

Scoring Rubric for Exercise 1

The **LEVEL 4** response provides *clear, consistent, and convincing* evidence of the ability to evaluate a student-designed experiment, identify the components of the experiment, analyze a student conclusion concerning the experiment, and discuss science content knowledge needed to understand the experiment.

Characteristics:

- An accurate and thorough identification of the control (if present), controlled variable(s)/constant(s), the dependent variable, and the independent variable of the experiment.
- An accurate and thorough identification of the errors found in a student work sample.
- An accurate identification and a thorough discussion of possible sources of error in an experimental design.
- An accurate and thorough identification and an informed discussion of errors in the correlation between the student hypothesis, conclusion, and collected data.
- An accurate and thorough discussion of the science content knowledge that is needed in order to understand the experiment.

The **LEVEL 3** response provides *clear* evidence of the ability to evaluate a student-designed experiment, identify the components of the experiment, analyze a student conclusion concerning the experiment, and discuss science content knowledge needed to understand the experiment.

Characteristics:

- An accurate identification of the control (if present), controlled variable(s)/constant(s), the dependent variable, and the independent variable of the experiment.
- An accurate identification of the errors found in a student work sample.
- An accurate identification and a discussion of possible sources of error in the experimental design, although the discussion may not be as thorough as a Level 4 response.
- An accurate identification and an informed discussion of errors in the correlation between the student hypothesis, conclusion, and collected data, but the discussion is not as informed as a Level 4 response.
- An accurate discussion of the science content knowledge that is needed in order to understand an experiment, although the discussion may not be as detailed as in a Level 4 response.

The **LEVEL 2** response provides *limited* evidence of the ability to evaluate a student-designed experiment, identify the components of the experiment, analyze a student conclusion concerning the experiment, and discuss science content knowledge needed to understand the experiment.

Characteristics:

- An incomplete identification of the control (if present), controlled variable(s)/constant(s), the dependent variable, and the independent variable of the experiment.
- An incomplete identification of the errors found in a student work sample.
- An incomplete identification or a limited discussion of possible sources of error in the experimental design.
- An accurate identification, but the discussion of errors in the correlation between the student hypothesis, conclusion, and collected data may only be partially related to the student errors, or the identification of errors is incomplete or limited.
- A discussion of the science content knowledge that is needed in order to understand the experiment is limited.

The **LEVEL 1** response provides *little or no* evidence of the ability to evaluate a student-designed experiment, identify the components of an experiment, analyze a student conclusion concerning the experiment, and discuss science content knowledge needed to understand the experiment.

Characteristics:


- An inaccurate or missing identification of the control (if present), controlled variable(s)/constant(s), the dependent variable, and the independent variable of the experiment.
- An inaccurate or missing identification of the errors found in a student work sample.
- An inaccurate identification or missing discussion of possible sources of error in the experimental design.
- An inaccurate or missing identification and discussion of errors in the correlation between the student hypothesis, conclusion, and collected data.
- A discussion of the science content knowledge that is needed in order to understand the experiment is inaccurate or missing.

Sample Exercise 2 and Scoring Rubric

Sample Exercise 2

Standard II. Knowledge of Science / Standard III. Curriculum and Instruction

Exercise 2: Contexts of Science - Candidate Name		⌚ Time Remaining 29:31
Contexts of Science		
<u>Introduction</u>		
In this exercise, you will use your knowledge of science to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society. You will be asked to respond to one prompt.		
<u>Criteria for Scoring</u>		
To satisfy the highest level of the scoring rubric, your response must provide clear, consistent, and convincing evidence of the following:		
<ul style="list-style-type: none">• an accurate and informed description of a major scientific event or discovery;• a thorough and insightful discussion of the scientific knowledge necessary to understand the event or discovery;• an accurate and thorough explanation of how another science discipline is related to the event or discovery; and• an informed description of effects the event or discovery has had on society.		
<u>Directions</u>		
You may view the prompt by clicking the Next button. Compose your response in the space provided.		
? Help	⌚ Navigator	Next →

Exercise 2: Contexts of Science - Candidate Name		 Time Remaining 29:31
<p>In September 1933, Leó Szilárd foreshadowed the possibility of a sustained nuclear reaction. Many of the best nuclear physicists were doing research in Germany at this time, and Szilárd was concerned that advances in nuclear fission could release an unconceivable amount of energy that could be utilized to make a bomb.</p> <p>In late 1939, Szilárd wrote a letter that Albert Einstein signed and sent to President Roosevelt. This resulted in the Manhattan Project, in which the United States developed the atomic bomb. After World War II, many of the scientists that worked on the Manhattan Project promoted peaceful applications of the nuclear fission process. As a result, efforts shifted from harnessing energy to make weapons to harnessing energy to generate electricity and for other applications of the nuclear fission process that are now part of our daily lives.</p>		
<p>You must address each of the following in your response.</p> <ul style="list-style-type: none">• Discuss the scientific event or discovery.• Discuss the science knowledge necessary to understand the event or discovery.• Explain how a science discipline other than chemistry is related to the event or discovery.• Describe two effects the event or discovery has had on society.		
? Help	⦿ Navigator	Next →

Scoring Rubric for Exercise 2

The **LEVEL 4** response provides *clear, consistent, and convincing* evidence of the ability to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society.

Characteristics:

- An accurate and thorough description of a major scientific event or discovery.
- A thorough and insightful discussion of the scientific knowledge necessary to understand the event or discovery.
- An accurate and thorough explanation of how another science discipline is related to the event or discovery.
- A thorough description of the effect the event or discovery has had on society.

The **LEVEL 3** response provides *clear* evidence of the ability to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society.

Characteristics:

- An accurate and informed description of a major scientific event or discovery.
- A thorough and complete discussion of the scientific knowledge necessary to understand the event or discovery, although the discussion may not be as thorough as a Level 4 response.
- An accurate and complete explanation of how another science discipline is related to the event or discovery, but the discussion is not as informed as a Level 4 response.
- An informed description of the effect the event or discovery has had on society, although the discussion may not be as detailed as in a Level 4 response.

The **LEVEL 2** response provides *limited* evidence of the ability to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society.

Characteristics:

- An incomplete description of a major scientific event or discovery.
- An incomplete discussion of the scientific knowledge necessary to understand the event or discovery.
- An incomplete explanation of how another science discipline is related to the event or discovery.
- An incomplete description of the effect the event or discovery has had on society.

The **LEVEL 1** response provides *little or no* evidence of the ability to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society.

Characteristics:


- An inaccurate or missing description of a major scientific event or discovery.
- An inaccurate or missing discussion of the scientific knowledge necessary to understand the event or discovery.
- An inaccurate or missing explanation of how another science discipline is related to the event or discovery.
- An inaccurate or missing description of the effect the event or discovery has had on society.

Sample Exercise 3 and Scoring Rubric

Sample Exercise 3

Standard II. Knowledge of Science / Standard III. Curriculum and Instruction /
Standard IV. Assessment

Exercise 3: Development of Scientific Concepts - Candidate Name		⌚ Time Remaining 29:31
Development of Scientific Concepts		
<u>Introduction</u>		
<p>In this exercise, you will demonstrate your knowledge of scientific conceptual development by evaluating and describing a student's conceptual understanding of scientific concepts, and by describing instruction that would help move the student toward the accepted understanding of the scientific concept. You will be asked to respond to one prompt.</p>		
<u>Criteria for Scoring</u>		
<p>To satisfy the highest level of the scoring rubric, your response must provide clear, consistent, and convincing evidence of the following:</p>		
<ul style="list-style-type: none">• an accurate evaluation of the student's conceptual understanding through examination of the student's work;• an accurate description of two scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding; and• an informed description of the instruction you would use to address the student's conceptual understanding.		
<u>Directions</u>		
<p>You may view the prompt by clicking the Next button. Compose your response in the space provided.</p>		
? Help	⌚ Navigator	Next →

Exercise 3: Development of Scientific Concepts -		 Time Remaining
Candidate Name		29:31
<p>A student wrote these observations and conclusions during a demonstration.</p> <p>The teacher added 30.0 milliliters (mL) of concentrated sulfuric acid to 60.0 grams (g) of sugar in a beaker in a fume hood. The total mass of the reactants was 90.0 g. As the reaction took place, a huge column of black foam began pouring out of the beaker. I predicted that the mass of the products would be greater than the mass of the reactants. The mass of the products definitely was greater than the mass of the reactants since the product took up more space than the original reactants. In the demonstration, matter was created when the teacher combined sugar with sulfuric acid.</p>		
<p>You must address each of the following in your response.</p> <ul style="list-style-type: none">• Evaluate the student’s conceptual understanding.• Describe in detail two scientific concepts the student would need to understand in order to move toward the accepted scientific understanding of the concept.• Briefly describe what you would do next in an instructional context to address the student’s conceptual understanding.		
? Help	⊙ Navigator	Next →

Scoring Rubric for Exercise 3

The **LEVEL 4** response provides *clear, consistent, and convincing* evidence of the ability to identify and describe the student’s conceptual understanding of a scientific concept; describe scientific concepts needed to improve conceptual understanding; and describe instruction that would help move the student toward the accepted understanding of the scientific concept.

Characteristics:

- An accurate and thorough identification of the student’s conceptual understanding through examination of the student’s work.
- An accurate and thorough description of two scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding.
- An informed and thorough description of the instruction you would use to address the student’s conceptual understanding.

The **LEVEL 3** response provides *clear* evidence of the ability to identify and describe the student’s conceptual understanding of a scientific concept; describe scientific concepts needed to improve conceptual understanding; and describe instruction that would help move the student toward the accepted understanding of the scientific concept.

Characteristics:

- An accurate identification of the student’s conceptual understanding through examination of the student’s work.
- An accurate description of two scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding, although the description may not be as thorough as a Level 4 response.
- An informed description of the instruction you would use to address the student’s conceptual understanding, although the description may not be as thorough as a Level 4 response.

The **LEVEL 2** response provides *limited* evidence of the ability to identify and describe the student's conceptual understanding of a scientific concept; describe scientific concepts needed to improve conceptual understanding; and describe instruction that would help move the student toward the accepted understanding of the scientific concept.

Characteristics:

- An incomplete identification of the student's conceptual understanding through examination of the student's work.
- An incomplete description of the scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding.
- An incomplete description of the instruction you would use to address the student's conceptual understanding.

The **LEVEL 1** response provides *little or no* evidence of the ability to identify and describe the student's conceptual understanding of a scientific concept; describe scientific concepts needed to improve conceptual understanding; and describe instruction that would help move the student toward the accepted understanding of the scientific concept.

Characteristics:

- An inaccurate or missing identification of the student's conceptual understanding through examination of the student's work.
- An inaccurate or missing description of two scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding.
- An inaccurate or missing description of the instruction you would use to address the student's conceptual understanding.

Reference Material for AYA/Science: Chemistry Component 1

This section includes the following about resources provided as part of the assessment:

- information about the online scientific calculator
- constants
- periodic table

Calculator Information

An online scientific calculator is available to you for this test. It is similar to the Texas Instruments handheld TI-30XS scientific calculator.

To access the calculator, click on the calculator icon located in the upper left corner of the screen. A pop-up window containing the calculator will appear. You can reposition the calculator by placing your cursor in the blue area above the calculator and dragging the window to the location of your choice.

Use the numbers on the keyboard and/or point and click with the mouse to enter your computations into the on-screen calculator. When you are finished, close the calculator by clicking the button in the upper right corner of the calculator.

Constants

CONSTANTS

Description	Value
Avogadro's number (N_A)	6.02×10^{23} particles/mole
Ideal gas constant (R)	$0.0821 \text{ L}\cdot\text{atm}/(\text{mol}\cdot\text{K}) = 8.31 \text{ J}/(\text{mol}\cdot\text{K})$
Faraday constant (F)	$9.65 \times 10^4 \text{ C/mol } e^- = 9.65 \times 10^4 \text{ J}/(\text{V}\cdot\text{mol } e^-)$
Boltzmann constant (k)	$1.38 \times 10^{-23} \text{ J/K}$
Rydberg constant (R_H)	$1.097 \times 10^7 \text{ m}^{-1}$
Planck's constant (h)	$6.63 \times 10^{-34} \text{ J}\cdot\text{s}$
Rydberg constant \times Planck's constant \times speed of light in a vacuum (R_Hhc)	$2.18 \times 10^{-18} \text{ J}$
Molal freezing point depression constant for water (K_f)	$1.86^\circ\text{C}/m$
Molal boiling point elevation constant for water (K_b)	$0.51^\circ\text{C}/m$
Heat of fusion of water (ΔH_{fus})	$334 \text{ J/g} = 80 \text{ cal/g} = 6.01 \text{ kJ/mol}$
Heat of vaporization of water (ΔH_{vap})	$2260 \text{ J/g} = 540 \text{ cal/g} = 40.7 \text{ kJ/mol}$
Specific heat (s) of water (liquid)	$4.184 \text{ J}/(\text{g}\cdot\text{K}) = 4.184 \text{ J}/(\text{g}\cdot^\circ\text{C}) = 1.0 \text{ cal}/(\text{g}\cdot^\circ\text{C})$
Dissociation constant of water (K_w)	1.0×10^{-14} at 25°C
Standard atmospheric pressure	$1 \text{ atm} = 760 \text{ mm Hg} = 760 \text{ torr} = 101.325 \text{ kPa}$
Speed of light in a vacuum (c)	$3.00 \times 10^8 \text{ m/s}$
1 watt (W)	1 J/s

NOTES FOR ADOLESCENCE AND YOUNG ADULTHOOD SCIENCE (CHEMISTRY) TEST

Not all constants necessary are listed, nor are all constants listed used on this test.

While attention has been paid to significant figures, no answer should be considered incorrect solely because of the number of significant figures.

Periodic Table

PERIODIC TABLE OF THE ELEMENTS

18																																																																											
8A																																																																											
1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18																																									
1A		2A		3B		4B		5B		6B		7B		8B		1B		2B		3A		4A		5A		6A		7A		8A																																													
1 H 1.01	2 He 4.00	3 Li 6.94	4 Be 9.01	5 Na 23.0	6 Mg 24.3	7 Sc 45.0	8 Ca 40.1	9 K 39.1	10 Ti 47.9	11 V 50.9	12 Cr 52.0	13 Mn 54.9	14 Fe 55.8	15 Co 58.9	16 Ni 58.7	17 Cu 63.5	18 Zn 65.4	19 Ga 69.7	20 Ge 72.6	21 As 74.9	22 Se 79.0	23 Br 79.9	24 Kr 83.8	25 Rb 85.5	26 Sr 87.6	27 Y 88.9	28 Zr 91.2	29 Nb 92.9	30 Mo 95.9	31 Tc 99.0	32 Ru 101.1	33 Rh 102.9	34 Pd 106.4	35 Ag 107.9	36 Cd 112.4	37 In 114.8	38 Sn 118.7	39 Sb 121.8	40 Te 127.6	41 I 126.9	42 Xe 131.3	43 Cs 132.9	44 Ba 137.3	45 La 138.9	46 Ce 140.1	47 Pr 140.9	48 Nd 144.2	49 Pm 144.9	50 Sm 150.4	51 Eu 152.0	52 Gd 157.3	53 Tb 158.9	54 Dy 162.5	55 Ho 164.9	56 Er 167.3	57 Tm 168.9	58 Yb 173.0	59 Lu 175.0	60 Fr 223.0	61 Ra 226.0	62 Ac 227.0	63 Th 232.0	64 Pa 231.0	65 U 238.0	66 Np 237.0	67 Pu 244.0	68 Am 243.0	69 Cm 247.0	70 Bk 247.0	71 Cf 251.0	72 Es 252.0	73 Fm 257.0	74 Md 288.0	75 No 289.0	76 Lr 260.0

Elements 113, 115, 117, and 118 have been reported, but they have not yet been named by the IUPAC. Standard atomic weight values are not listed for elements with no stable isotopes. Conventional atomic weights have been provided for B, C, Cl, H, Li, N, O, Si, S, and Ti.

AYA Science: Earth/Space—Overview

This document provides information about the Adolescence and Young Adulthood Science: Earth/Space (AYA/Science: Earth/Space) Component 1 computer-based assessment. It includes sample assessment center selected response items and answer key, constructed response exercises, and the scoring rubric used to assess each constructed response exercise.

Component 1: Content Knowledge

Component 1: Content Knowledge is a computer-based assessment requiring candidates to demonstrate knowledge of and pedagogical practices for their teaching content area. Candidates must demonstrate knowledge of developmentally appropriate content, which is necessary for teaching across the full age range and ability level of the chosen certificate area.

AYA/Science: Earth/Space Component 1 Computer-Based Assessment

In the AYA/Science: Earth/Space Component 1 computer-based assessment, content knowledge is assessed through the completion of approximately 45 selected response items and three constructed response exercises.

AYA/Science: Earth/Space Standards Measured by Selected Response Items

The AYA/Science: Earth/Space selected response items focus on the following Standards:

Standards Content	Approximate Percentage of Selected Response Item Section*
<p>Knowledge of Science Practices and Context (Standard II)</p> <ul style="list-style-type: none"> • Nature of Science • Understanding of Inquiry • Context of Science 	<p>20%</p>
<p>Knowledge of Science Content (Standard II)</p> <ul style="list-style-type: none"> • Earth and Space Science • Life Science • Physical Science—Chemistry • Physical Science—Physics 	<p>60% (45% in specialty 15% from other disciplines)</p>
<p>Curriculum, Instruction, and Learning Environment (Standards III, V)</p> <ul style="list-style-type: none"> • Crosscutting Principles • Assessing and addressing preconceptions • Safety 	<p>20%</p>

* These percentages are an approximation only.

For the complete AYA/Science: Earth/Space Standards, refer to www.nbpts.org/national-board-certification/candidate-center/.

AYA/Science: Earth/Space Constructed Response Exercises

The AYA/Science: Earth/Space constructed response exercises assess the following:

- **Exercise 1: Data Analysis**
In this exercise, you will use your knowledge of science to read a description of a student-designed investigation, study a student collection of data, and analyze a student conclusion concerning the investigation. You will be asked to respond to one prompt.
- **Exercise 2: Contexts of Science**
In this exercise, you will use your knowledge of science to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society. You will be asked to respond to one prompt.
- **Exercise 3: Development of Scientific Concepts**
In this exercise, you will demonstrate your knowledge of scientific conceptual development by evaluating and describing a student’s conceptual understanding of scientific concepts, and by describing instruction that would help move the student toward the accepted understanding of the scientific concept. You will be asked to respond to one prompt.

Each constructed response exercise will be assessed using a scoring rubric. Each AYA/Science: Earth/Space Component 1 scoring rubric is derived from the Science Standards and defines the levels of accomplished teaching that you must demonstrate.

You should read the rubric while preparing to take Component 1 to understand how the rubric guides assessors in evaluating your responses to the constructed response exercises.

Inside This Document

This document includes the following three sections: "[Sample Selected Response Items and Answer Key for AYA/Science: Earth/Space Component 1](#)," "[Sample Constructed Response Exercises and Scoring Rubrics for AYA/Science: Earth/Space Component 1](#)," and "[Reference Material for AYA/Science: Earth/Space Component 1](#)."

Selected Response Section

This section includes the following:

- sample selected response items
- answer key

Constructed Response Section

This section includes the following:

- three sample constructed response exercises
- associated scoring rubric for each exercise

Reference Material Section

This section includes the following about resources provided as part of the assessment:

- calculator information
- constants
- periodic table

Other Important Information

Refer to the National Board website for the following:

- For information about scheduling and taking your test at the assessment center, please refer to the *Assessment Center Policy and Guidelines*.
- For a link to an online tutorial, please refer to the *Assessment Center Testing* page.
- For more information about how the assessment is scored, please refer to the *Scoring Guide*.

Sample Selected Response Items and Answer Key for AYA/Science: Earth/Space Component 1

This section includes

- **sample selected response items** to help you become familiar with the content and format of the items on an actual computer-based assessment.

Although this section illustrates some of the types of items that appear on the assessment, note that these sample items do not necessarily define the content or difficulty of an entire actual assessment.

Please note that the selected response items cover the *entire* age range of the certificate. Be aware that you are expected to demonstrate knowledge of developmentally appropriate content across the full range of your certificate.

- an **answer key**.

Sample Selected Response Items

Standard II. Knowledge of Science (Practices and Context)

1. Earth science students use classification systems, including dichotomous keys, to help identify rocks. Which of the following methods would yield the most accurate, reproducible results in identifying rocks?
 - A. sorting first by streak color, then by smell
 - B. sorting first by texture, then by composition
 - C. sorting first by sample size, then by components
 - D. sorting first by crystal arrangement, then by shape

Standard II. Knowledge of Science (Content)

2. Volcanic eruptions can range from explosive to relatively quiet events. The more explosive ones, such as the eruptions of Mount Pinatubo in 1991 and Mount Saint Helens in 1980, contrast with the lava flows of effusive volcanoes. The geochemical system most likely to produce a highly explosive volcanic eruption would typically involve magma with which of the following characteristics?
- A. a relatively high concentration of covalently bonded silicon-oxygen tetrahedra (SiO_4^{4-}) and abundant dissolved gases
 - B. a relatively low ratio of silicon cations (Si^+) to oxygen anions (O^{2-}) and a low vapor pressure
 - C. a relatively high concentration of magnesium (Mg^{2+}) and iron (Fe^{2+}) cations and a high melting-point temperature
 - D. a relatively low proportion of dissolved water vapor and carbon dioxide (CO_2) and a high confining pressure

Standard II. Knowledge of Science (Content)

3. Meiosis is a reduction division that produces haploid daughter cells from diploid parent cells. Meiosis is important because it:
- A. constitutes the main process by which somatic cells are produced in multicellular organisms.
 - B. produces the maximum number of haploid daughter cells resulting in a greater number of offspring.
 - C. provides the mechanism for storing genetic information from unduplicated chromosomes as they become visible and compact.
 - D. increases the genetic diversity of the organism through the processes of independent assortment and crossing-over of the chromosomes.

Standard II. Knowledge of Science (Content)

4. A student pushed a load up to an equal height on two different inclined planes. The student observed that less force was required to push the load up inclined plane 2 than inclined plane 1. Which of the following statements best explains the student's observation?
- A. Inclined plane 2 had a longer ramp than inclined plane 1.
 - B. Inclined plane 2 required less work than inclined plane 1.
 - C. Inclined plane 2 had less mechanical advantage than inclined plane 1.
 - D. Inclined plane 2 decreased the load weight more than inclined plane 1.

Standard III. Curriculum and Instruction

5. A teacher makes a model that shows the motions of Earth revolving around the Sun. Which student misconception could the model help to clarify?
- A. The phases of the Moon are the result of Earth's revolution.
 - B. Tides are affected equally by the gravity of the Moon and the Sun.
 - C. Earth is closer to the Sun during summer in the Northern Hemisphere.
 - D. The angle of insolation is always greatest at solar noon at any location on Earth.

Standard III. Curriculum and Instruction

6. A teacher discovers that although most students in a class can complete calculations using Newton's law of universal gravitation, many of them hold the common misconception that more massive objects fall faster than less massive objects when in free fall without air resistance. Analysis of which of the following mathematical expressions is most likely to clear up this misconception?
- A. the force-to-mass ratio defined by Newton's second law that shows gravitational acceleration of more and less massive objects is equal
 - B. the inverse relationship between an object's mass and its velocity and the direct relationship between the force acting on the object and its weight
 - C. the action-reaction pairing described by Newton's third law that shows both Earth and a mass falling toward it exert equal and opposite forces on each other
 - D. the inverse relationship between the gravitational force acting on an object and the object's distance from the larger attracting mass

Answer Key to Sample Selected Response Items

Item Number	Correct Response
1	B
2	A
3	D
4	A
5	C
6	A

Sample Constructed Response Exercises and Scoring Rubrics for AYA/Science: Earth/Space Component 1

This section includes

- **sample constructed response exercises** to help you become familiar with the content and format of the exercises on an actual computer-based assessment. These exercises include instructions for using the computer, stimulus materials (if applicable), and prompts requiring responses.

Although this section illustrates some of the types of exercises that appear on the assessment, note that these sample exercises do not necessarily define the content or difficulty of the exercises on an actual assessment.

Please note these constructed response exercises cover the **entire** age range of the certificate. Be aware that you are expected to demonstrate knowledge of developmentally appropriate content across the full range of your certificate.

- **scoring rubrics** that are used by assessors in evaluating your responses to help you understand how your responses are assessed.

Sample Exercise 1 and Scoring Rubric

Sample Exercise 1

Standard II. Knowledge of Science / Standard IV. Assessment

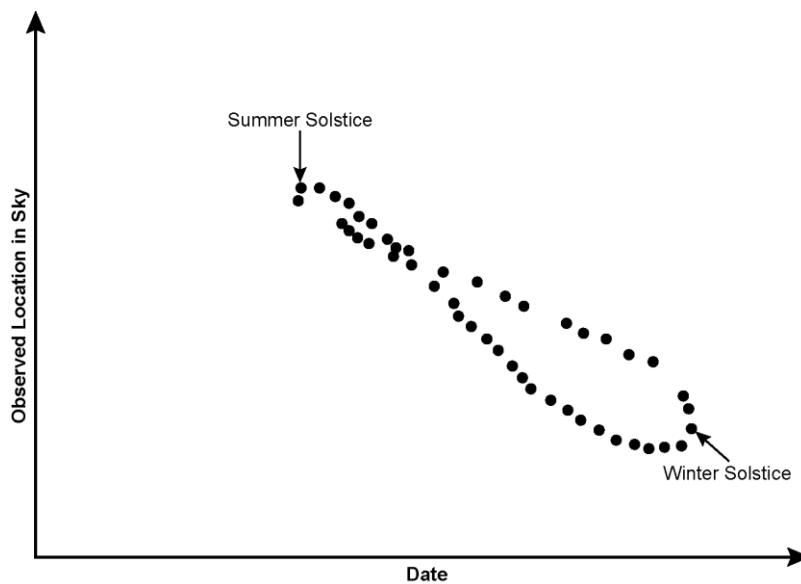
Exercise 1: Data Analysis - Candidate Name		⌚ Time Remaining 29:31
Data Analysis		
<u>Introduction</u>		
In this exercise, you will use your knowledge of science to read a description of a student-designed investigation (e.g., experiment, simulation, investigation), study a student collection of data, and analyze a student conclusion concerning the investigation. You will be asked to respond to one prompt.		
<u>Criteria for Scoring</u>		
To satisfy the highest level of the scoring rubric, your response must provide clear, consistent, and convincing evidence of the following:		
<ul style="list-style-type: none">• an accurate identification of the components of the investigation;• an accurate identification of the errors found in the student work sample;• an accurate identification and a thorough discussion of possible sources of error in the investigation;• an accurate identification and an informed discussion of errors in the correlation between the student hypothesis, conclusion, and collected data; and• an accurate discussion of the science content knowledge that is needed in order to understand an investigation.		
<u>Directions</u>		
You may view the prompt by clicking the Next button. Compose your response in the space provided.		
? <u>H</u> elp	⦿ <u>N</u> avigator	<u>N</u> ext →

Exercise 1: Data Analysis - Candidate Name

 Time Remaining
29:31

Below is a student-prepared abstract of an astronomy investigation.

In order to answer the question "How does the sun appear to move throughout the sky during the course of a year?" a series of photographs were taken from the very same location, using the same camera settings at the same time every few days for a year. The locations of the sun were then plotted on the graph for that year. On many days there was cloud cover so there are some missing points of data. The Summer Solstice and the Winter Solstice were noted on the graph. It was concluded that the sun does move significantly throughout the year and it looks like the positions of the sun trace "a figure eight" in the sky, which is called the analemma. Since Earth is closer to the sun when the Northern Hemisphere is experiencing Summer Solstice, the dots are closer on the graph. The "figure eight" shape is due to the elliptical shape of the orbit of Earth around the sun.



You must address each of the following in your response.

- Identify the **control (if present)**, **constant(s) (if present)**, the **dependent variable**, and the **independent variable**.
- Identify the **errors** found in the mechanics of the graph.
- Identify and thoroughly discuss the possible **sources of error** resulting from the investigation.
- Identify and discuss **errors** in the correlation between the **hypothesis**, the **conclusion**, and the **collected data**.
- Discuss **two** concepts related to the motions of Earth and the sun that a **high school** student must know to understand this investigation.

? Help

⦿ Navigator

Next →

Scoring Rubric for Exercise 1

The **LEVEL 4** response provides *clear, consistent, and convincing* evidence of the ability to evaluate a student-designed investigation, identify the components of the investigation, analyze a student conclusion concerning the investigation, and discuss science content knowledge needed to understand the investigation.

Characteristics:

- An accurate and thorough identification of the control (if present), constant(s) (if present), dependent variable, and independent variable of the investigation.
- An accurate and thorough identification of the errors found in a student work sample.
- An accurate identification and a thorough discussion of possible sources of error in the investigation.
- An accurate and thorough identification and an informed discussion of errors in the correlation between the student hypothesis, conclusion, and collected data.
- An accurate and thorough discussion of the science content knowledge that is needed in order to understand the investigation.

The **LEVEL 3** response provides *clear* evidence of the ability to evaluate a student-designed investigation, identify the components of the investigation, analyze a student conclusion concerning the investigation, and discuss science content knowledge needed to understand the investigation.

Characteristics:

- An accurate identification of the control (if present), constant(s) (if present), dependent variable, and independent variable of the investigation.
- An accurate identification of the errors found in a student work sample.
- An accurate identification and a discussion of possible sources of error in the investigation, although the discussion may not be as thorough as a Level 4 response.
- An accurate identification and an informed discussion of errors in the correlation between the student hypothesis, conclusion, and collected data, but the discussion is not as informed as a Level 4 response.
- An accurate discussion of the science content knowledge that is needed in order to understand the investigation, although the discussion may not be as detailed as in a Level 4 response.

The **LEVEL 2** response provides *limited* evidence of the ability to evaluate a student-designed investigation, identify the components of the investigation, analyze a student conclusion concerning the investigation, and discuss science content knowledge needed to understand the investigation.

Characteristics:

- An incomplete identification of the control (if present), constant(s) (if present), dependent variable, and independent variable of the investigation.
- An incomplete identification of the errors found in a student work sample.
- An incomplete identification or a limited discussion of possible sources of error in the investigation.
- An accurate identification but the discussion of errors in the correlation between the student hypothesis, conclusion, and collected data may only be partially related to the student errors, or the identification of errors is incomplete or limited.
- A discussion of the science content knowledge that is needed in order to understand the investigation is limited.

The **LEVEL 1** response provides *little or no* evidence of the ability to evaluate a student-designed investigation, identify the components of an investigation, analyze a student conclusion concerning the investigation, and discuss science content knowledge needed to understand the investigation.

Characteristics:

- An inaccurate or missing identification of the control (if present), constant(s) (if present), dependent variable, and independent variable of the investigation.
- An inaccurate or missing identification of the errors found in a student work sample.
- An inaccurate identification or missing discussion of possible sources of error in the investigation.
- An inaccurate or missing identification and discussion of errors in the correlation between the student hypothesis, conclusion, and collected data.
- A discussion of the science content knowledge that is needed in order to understand the investigation is inaccurate or missing.

Sample Exercise 2 and Scoring Rubric

Sample Exercise 2

Standard II. Knowledge of Science / Standard III. Curriculum and Instruction

Exercise 2: Contexts of Science - Candidate Name		ⓘ Time Remaining 29:31
Contexts of Science		
<u>Introduction</u>		
In this exercise, you will use your knowledge of science to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society. You will be asked to respond to one prompt.		
<u>Criteria for Scoring</u>		
To satisfy the highest level of the scoring rubric, your response must provide clear, consistent, and convincing evidence of the following:		
<ul style="list-style-type: none">• an accurate and informed description of a major scientific event or discovery;• a thorough and insightful discussion of the scientific knowledge necessary to understand the event or discovery;• an accurate and thorough explanation of how another science discipline is related to the event or discovery; and• an informed description of effects the event or discovery has had on society.		
<u>Directions</u>		
You may view the prompt by clicking the Next button. Compose your response in the space provided.		
? Help	⦿ Navigator	Next →

Exercise 2: Contexts of Science - Candidate Name		ⓘ Time Remaining 29:31
An earth and space science teacher paired students to study the history of plate tectonics. One member of each pair had an earth science textbook copyrighted in 1969 and the other member had a textbook with a copyright of 1985. The 1969 textbook did not include the plate tectonics theory, whereas the 1985 textbook did. The students compared how earthquakes, volcanoes, and other phenomena were explained in both text books.		
You must address each of the following in your response.		
<ul style="list-style-type: none">• Discuss the scientific event or discovery.• Discuss the science knowledge necessary to understand the event or discovery.• Explain how a science discipline other than earth and space science is related to the event or discovery.• Discuss two effects the event or discovery has had on society.		
? Help	⦿ Navigator	Next →

Scoring Rubric for Exercise 2

The **LEVEL 4** response provides *clear, consistent, and convincing* evidence of the ability to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society.

Characteristics:

- An accurate and thorough description of a major scientific event or discovery.
- A thorough and insightful discussion of the scientific knowledge necessary to understand the event or discovery.
- An accurate and thorough explanation of how another science discipline is related to the event or discovery.
- A thorough description of the effects the event or discovery has had on society.

The **LEVEL 3** response provides *clear* evidence of the ability to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society.

Characteristics:

- An accurate and informed description of a major scientific event or discovery.
- A thorough and complete discussion of the scientific knowledge necessary to understand the event or discovery, although the discussion may not be as thorough as a Level 4 response.
- An accurate and complete explanation of how another science discipline is related to the event or discovery, but the discussion is not as informed as a Level 4 response.
- An informed description of the effects the event or discovery has had on society, although the discussion may not be as detailed as in a Level 4 response.

The **LEVEL 2** response provides *limited* evidence of the ability to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society.

Characteristics:

- An incomplete description of a major scientific event or discovery.
- An incomplete discussion of the scientific knowledge necessary to understand the event or discovery.
- An incomplete explanation of how another science discipline is related to the event or discovery.
- An incomplete description of the effects the event or discovery has had on society.

The **LEVEL 1** response provides *little or no* evidence of the ability to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society.

Characteristics:

- An inaccurate or missing description of a major scientific event or discovery.
- An inaccurate or missing discussion of the scientific knowledge necessary to understand the event or discovery.
- An inaccurate or missing explanation of how another science discipline is related to the event or discovery.
- An inaccurate or missing description of the effects the event or discovery has had on society.

Sample Exercise 3 and Scoring Rubric

Sample Exercise 3

Standard II. Knowledge of Science / Standard III. Curriculum and Instruction /
Standard IV. Assessment

Exercise 3: Development of Scientific Concepts - Candidate Name		⌚ Time Remaining 29:31
Development of Scientific Concepts		
<u>Introduction</u>		
<p>In this exercise, you will demonstrate your knowledge of scientific conceptual development by evaluating and describing a student's conceptual understanding of scientific concepts, and by describing instruction that would help move the student toward the accepted understanding of the scientific concept. You will be asked to respond to one prompt.</p>		
<u>Criteria for Scoring</u>		
<p>To satisfy the highest level of the scoring rubric, your response must provide clear, consistent, and convincing evidence of the following:</p>		
<ul style="list-style-type: none">• an accurate evaluation of the student's conceptual understanding through examination of the student's work;• an accurate description of two scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding; and• an informed description of the instruction you would use to address the student's conceptual understanding.		
<u>Directions</u>		
<p>You may view the prompt by clicking the Next button. Compose your response in the space provided.</p>		
? Help	⦿ Navigator	Next →

Exercise 3: Development of Scientific Concepts -
Candidate Name

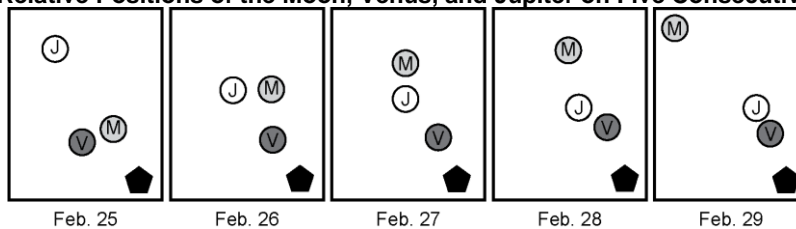
 **Time Remaining**
29:31





A student was assigned to write an abstract for a laboratory report based on an astronomy experiment.

Student Response

In order to study the movements of objects in the evening sky, a digital camera was used on several nights about the same time and facing West each night in late February. The movements of the Moon, Jupiter and Venus were observed and examined. Diagrams of the relative location of the Moon, Venus and Jupiter were prepared from those digital images. It was concluded that the Moon moves more quickly than the two planets because the planets are further away from Earth than the Moon. In addition, it was noticed that the Moon was moving rapidly towards the southern part of the sky while the planets were moving in the northerly direction in the sky. Therefore the collected data show that within 6 months, the Moon will appear in the southern part of the sky while the planets will appear in the northern part of the sky.

The Relative Positions of the Moon, Venus, and Jupiter on Five Consecutive Nights



Key	
	Jupiter
	Moon
	Venus
	Pine Tree

You must address each of the following in your response.

- Evaluate the student's conceptual understanding.
- Describe in detail **two** scientific concepts the student would need to understand in order to move toward the accepted scientific understanding of the concept presented in the stimulus.
- Briefly describe what you would do next in an instructional context to address the student's conceptual understanding.

? [Help](#)

 [Navigator](#)

[Next](#) 

Scoring Rubric for Exercise 3

The **LEVEL 4** response provides *clear, consistent, and convincing* evidence of the ability to identify and describe the student’s conceptual understanding of a scientific concept, describe scientific concepts needed to improve conceptual understanding, and describe how the student can be instructed in order to move toward the accepted understanding of the scientific concept.

Characteristics:

- An accurate and thorough identification of the student’s conceptual understanding through examination of the student’s work.
- An accurate and thorough description of two scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding.
- An informed and thorough description of the instruction you would use to address the student’s conceptual understanding.

The **LEVEL 3** response provides *clear* evidence of the ability to identify and describe the student’s conceptual understanding of a scientific concept, describe scientific concepts needed to improve conceptual understanding, and describe how the student can be instructed in order to move toward the accepted understanding of the scientific concept.

Characteristics:

- An accurate identification of the student’s conceptual understanding through examination of the student’s work.
- An accurate description of two scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding, although the description may not be as thorough as a Level 4 response.
- An informed description of the instruction you would use to address the student’s conceptual understanding, although the description may not be as thorough as a Level 4 response.

The **LEVEL 2** response provides *limited* evidence of the ability to identify and describe the student's conceptual understanding of a scientific concept, describe scientific concepts needed to improve conceptual understanding, and describe how the student can be instructed in order to move toward the accepted understanding of the scientific concept.

Characteristics:

- An incomplete identification of the student's conceptual understanding through examination of the student's work.
- An incomplete description of two scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding.
- An incomplete description of the instruction you would use to address the student's conceptual understanding.

The **LEVEL 1** response provides *little or no* evidence of the ability to identify and describe the student's conceptual understanding of a scientific concept, describe scientific concepts needed to improve conceptual understanding, and describe how the student can be instructed in order to move toward the accepted understanding of the scientific concept.

Characteristics:

- An inaccurate or missing identification of the student's conceptual understanding through examination of the student's work.
- An inaccurate or missing description of two scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding.
- An inaccurate or missing description of the instruction you would use to address the student's conceptual understanding.

Reference Material for AYA/Science: Earth/Space Component

1

This section includes the following about resources provided as part of the assessment:

- information about the online scientific calculator
- constants
- periodic table

Calculator Information

An online scientific calculator is available to you for this test. It is similar to the Texas Instruments handheld TI-30XS scientific calculator.

To access the calculator, click on the calculator icon located in the upper left corner of the screen. A pop-up window containing the calculator will appear. You can reposition the calculator by placing your cursor in the blue area above the calculator and dragging the window to the location of your choice.

Use the numbers on the keyboard and/or point and click with the mouse to enter your computations into the on-screen calculator. When you are finished, close the calculator by clicking the button in the upper right corner of the calculator.

Constants

CONSTANTS

Description	Value
Standard atmospheric pressure	1 atm = 760 mm Hg = 1013.25 mb = 101.325 kPa
Speed of light in a vacuum (c)	3.00×10^8 m/s
1 watt (W)	1 J/s
Acceleration of gravity on Earth (g)	9.80 m/s ²
Gravitational constant (G)	6.67×10^{-11} N·m ² /kg ²
Avogadro's number (N_A)	6.02×10^{23} particles/mole
Ideal gas constant (R)	0.0821 L·atm/(mol·K) = 8.31 J/(mol·K)
Specific heat (s) of water (liquid)	4.184 J/(g·K) = 4.184 J/(g·°C) = 1.0 cal/(g·°C)

NOTES FOR ADOLESCENCE AND YOUNG ADULTHOOD SCIENCE (EARTH/SPACE) TEST

Not all constants necessary are listed, nor are all constants listed used on this test.

While attention has been paid to significant figures, no answer should be considered incorrect solely because of the number of significant figures.

Periodic Table

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1A	2A							8B		1B	2B	3A	4A	5A	6A	7A	8A
1 H 1.01	2 He 4.00	3 Li 6.94	4 Be 9.01	5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18	11 Na 23.0	12 Mg 24.3	13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 39.9
19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc 99.9	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57-71 Lanthanide Series	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po 209.0	85 At 209.0	86 Rn 222.0
87 Fr	88 Ra	89-103 Actinide Series	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Lv	116 Lv	117 Ts	118 Og

57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
89 Ac	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Elements 113, 115, 117, and 118 have been reported, but they have not yet been named by the IUPAC.
Standard atomic weight values are not listed for elements with no stable isotopes.
Conventional atomic weights have been provided for B, C, Cl, H, Li, N, O, Si, S, and Ti.

AYA Science: Physics—Overview

This document provides information about the Adolescence and Young Adulthood Science: Physics (AYA/Science: Physics) Component 1 computer-based assessment. It includes sample assessment center selected response items and answer key, constructed response exercises, and the scoring rubric used to assess each constructed response exercise.

Component 1: Content Knowledge

Component 1: Content Knowledge is a computer-based assessment requiring candidates to demonstrate knowledge of and pedagogical practices for their teaching content area. Candidates must demonstrate knowledge of developmentally appropriate content, which is necessary for teaching across the full age range and ability level of the chosen certificate area.

AYA/Science: Physics Component 1 Computer-Based Assessment

In the AYA/Science: Physics Component 1 computer-based assessment, content knowledge is assessed through the completion of approximately 45 selected response items and three constructed response exercises.

AYA/Science: Physics Standards Measured by Selected Response Items

The AYA/Science: Physics selected response items focus on the following Standards:

Standards Content	Approximate Percentage of Selected Response Item Section*
<p>Knowledge of Science Practices and Context (Standard II)</p> <ul style="list-style-type: none"> • Nature of Science • Understanding of Inquiry • Context of Science 	20%
<p>Knowledge of Science Content (Standard II)</p> <ul style="list-style-type: none"> • Earth and Space Science • Life Science • Physical Science–Chemistry • Physical Science–Physics 	60% (45% in specialty 15% from other disciplines)
<p>Curriculum, Instruction, and Learning Environment (Standards III, V)</p> <ul style="list-style-type: none"> • Crosscutting Principles • Assessing and addressing preconceptions • Safety 	20%

* These percentages are an approximation only.

For the complete AYA/Science: Physics Standards, refer to www.nbpts.org/national-board-certification/candidate-center/.

AYA/Science: Physics Constructed Response Exercises

The AYA/Science: Physics constructed response exercises assess the following:

- **Exercise 1: Data Analysis**
In this exercise, you will use your knowledge of science to read a description of a student-designed investigation, study a student collection of data, and analyze a student conclusion concerning the investigation. You will be asked to respond to one prompt.
- **Exercise 2: Contexts of Science**
In this exercise, you will use your knowledge of science to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society. You will be asked to respond to one prompt.
- **Exercise 3: Development of Scientific Concepts**
In this exercise, you will demonstrate your knowledge of scientific conceptual development by evaluating and describing a student's conceptual understanding of scientific concepts, and by describing instruction that would help move the student toward the accepted understanding of the scientific concept. You will be asked to respond to one prompt.

Each constructed response exercise will be assessed using a scoring rubric. Each AYA/Science: Physics Component 1 scoring rubric is derived from the Science Standards and defines the levels of accomplished teaching that you must demonstrate.

You should read the rubric while preparing to take Component 1 to understand how the rubric guides assessors in evaluating your responses to the constructed response exercises.

Inside This Document

This document includes the following three sections: "[Sample Selected Response Items and Answer Key for AYA/Science: Physics Component 1](#)," "[Sample Constructed Response Exercises and Scoring Rubrics for AYA/Science: Physics Component 1](#)," and "[Reference Material for AYA/Science: Physics Component 1](#)."

Selected Response Section

This section includes the following:

- sample selected response items
- answer key

Constructed Response Section

This section includes the following:

- three sample constructed response exercises
- associated scoring rubric for each exercise

Reference Material Section

This section includes the following about resources provided as part of the assessment:

- calculator information
- constants
- periodic table

Other Important Information

Refer to the National Board website for the following:

- For information about scheduling and taking your test at the assessment center, please refer to the *Assessment Center Policy and Guidelines*.
- For a link to an online tutorial, please refer to the *Assessment Center Testing* page.
- For more information about how the assessment is scored, please refer to the *Scoring Guide*.

Sample Selected Response Items and Answer Key for AYA/Science: Physics Component 1

This section includes

- **sample selected response items** to help you become familiar with the content and format of the items on an actual computer-based assessment.

Although this section illustrates some of the types of items that appear on the assessment, note that these sample items do not necessarily define the content or difficulty of an entire actual assessment.

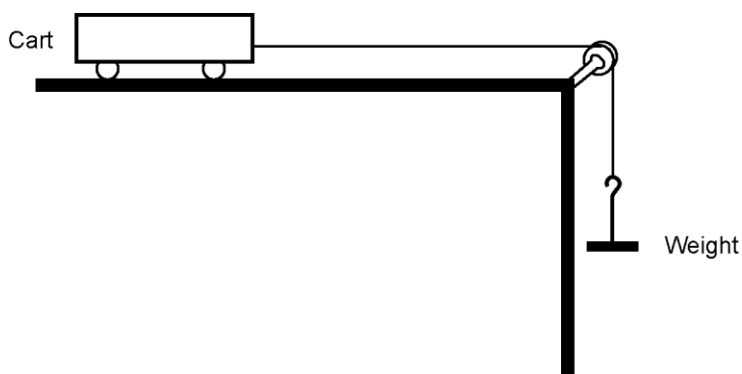
Please note that the selected response items cover the *entire* age range of the certificate. Be aware that you are expected to demonstrate knowledge of developmentally appropriate content across the full range of your certificate.

- an **answer key**.

Sample Selected Response Items

Standard II. Knowledge of Science (Practices and Context)

1. A student interested in investigating Newton's second law of motion sets up the apparatus shown.



If the independent variable in the student's experiment is the weight of the object hanging from the pulley, what is the dependent variable?

- A. the mass of the cart
- B. the velocity of the cart
- C. the acceleration of the cart
- D. the displacement of the cart

Standard II. Knowledge of Science (Content)

2. Within a trophic pyramid, all grasshoppers in a community represent an energy production value of $560 \text{ kcal/m}^2/\text{year}$, and the toads that feed on grasshoppers represent an energy value of $48 \text{ kcal/m}^2/\text{year}$. What is the best explanation for this finding?
- A. Most of the energy from one trophic level is incorporated into the biomass of the next level.
 - B. Energy production efficiency in an entire community is highest for the primary consumer trophic level.
 - C. The energy lost in cellular respiration is approximately one-half of the available energy for a trophic level.
 - D. Only about one-tenth of the energy consumed by a trophic level is sequestered in its tissues and made available to the next level.

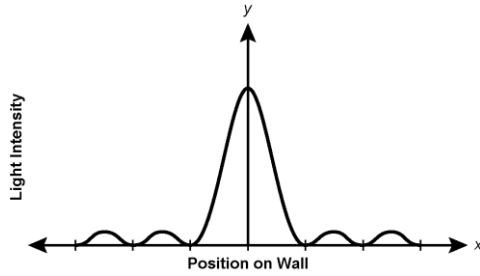
Standard II. Knowledge of Science (Content)

3. A solid has a melting point of $1,440^\circ\text{C}$. It conducts heat and electricity, and it does not dissolve in water or in organic solvents. Which type of bond is present in the solid?
- A. ionic
 - B. dipole
 - C. metallic
 - D. covalent

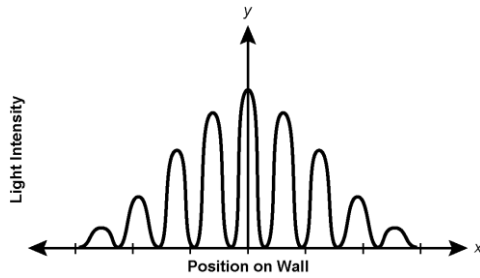
Standard II. Knowledge of Science (Content)

4. Graphs can be used to represent a diffraction pattern of monochromatic light projected onto a wall. Which graph most closely represents the pattern expected from a double-slit opening?

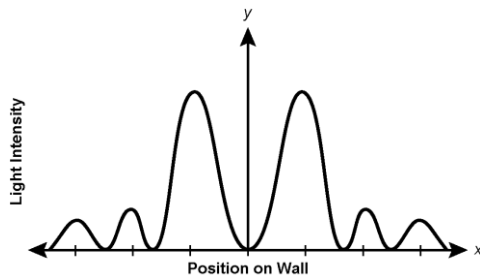
A.



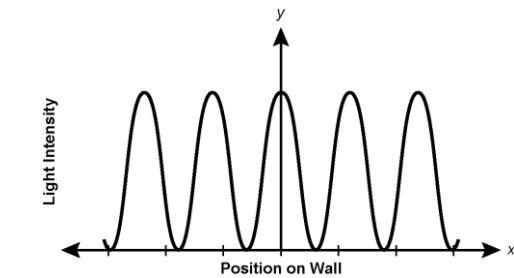
B.



C.



D.



Standard III. Curriculum and Instruction

5. A student claims that an object moving at a constant speed has no net force acting on it. Which of the following is a clear counterexample to this claim?
- A. a ball on a string is spun in a horizontal circle at a constant speed
 - B. an ice skater glides along a straight line on ice at a constant speed
 - C. a mass attached to string is pulled across a rough surface at a constant speed
 - D. a skydiver who jumps from a plane falls toward Earth at terminal velocity

Standard III. Curriculum and Instruction

6. Students are conducting a kinematics lab utilizing an ultrasonic motion sensor lab interface, a ramp, and a dynamics cart.
- 1. Students should prepare for their laboratory experience by reading the laboratory procedure ahead of time.
 - 2. Safety goggles and gloves should be worn by all students.
 - 3. Contact lenses should be removed and stored elsewhere. Wear regular eyeglasses on lab day.
 - 4. No food or beverages are allowed in the laboratory.
 - 5. Apparel for lab days should include closed-toe shoes and no long-hanging necklaces or long, loose hair.
- Which set of safety practices listed above is best suited to this kinematics lab?
- A. 1, 4, and 5
 - B. 1, 2, and 4
 - C. 1, 2, and 5
 - D. 1, 3, and 4

Answer Key to Sample Selected Response Items

Item Number	Correct Response
1	C
2	D
3	C
4	B
5	A
6	A

Sample Constructed Response Exercises and Scoring Rubrics for AYA/Science: Physics Component 1

This section includes

- **sample constructed response exercises** to help you become familiar with the content and format of the exercises on an actual computer-based assessment. These exercises include instructions for using the computer, stimulus materials (if applicable), and prompts requiring responses.

Although this section illustrates some of the types of exercises that appear on the assessment, note that these sample exercises do not necessarily define the content or difficulty of the exercises on an actual assessment.

Please note these constructed response exercises cover the **entire** age range of the certificate. Be aware that you are expected to demonstrate knowledge of developmentally appropriate content across the full range of your certificate.

- **scoring rubrics** that are used by assessors in evaluating your responses to help you understand how your responses are assessed.

Sample Exercise 1 and Scoring Rubric

Sample Exercise 1

Standard II. Knowledge of Science / Standard IV. Assessment

Exercise 1: Data Analysis - Candidate Name 🕒 **Time Remaining**
29:31

Data Analysis

Introduction

In this exercise, you will use your knowledge of science to read a description of a student-designed investigation (e.g., experiment, simulation, investigation), study a student collection of data, and analyze a student conclusion concerning the investigation. You will be asked to respond to one prompt.

Criteria for Scoring

To satisfy the highest level of the scoring rubric, your response must provide clear, consistent, and convincing evidence of the following:

- an accurate identification of the components of the investigation;
- an accurate identification of mistakes present in the student work sample;
- an accurate identification and a thorough discussion of possible sources of error in the investigative design;
- an accurate identification and an informed discussion of student mistakes in the correlation between the student hypothesis, conclusion, and collected data; and
- an accurate discussion of the science content knowledge that is needed in order to understand an investigation.

Directions

You may view the prompt by clicking the **Next** button. Compose your response in the space provided.

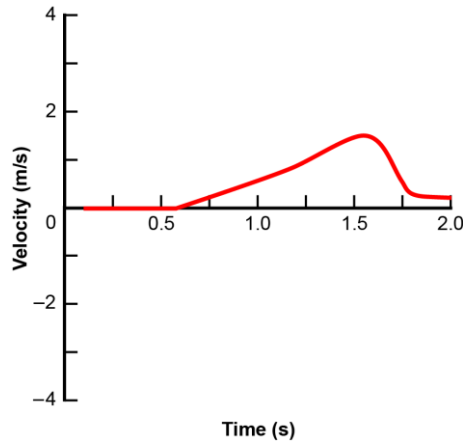
? Help🕒 NavigatorNext →

Exercise 1: Data Analysis - Candidate Name

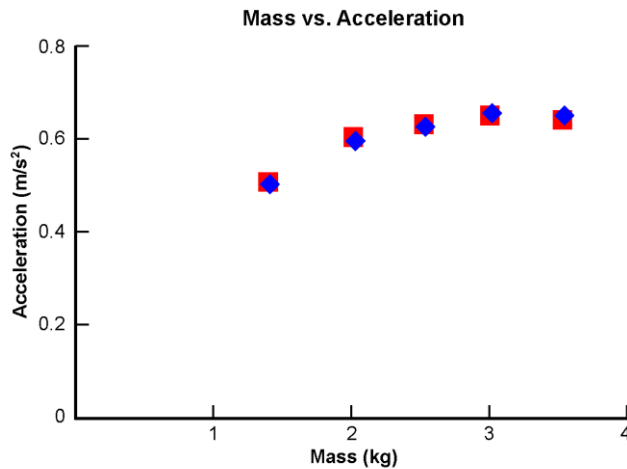
 Time Remaining
29:31



A physics student hypothesized that adding mass to a cart does not affect the acceleration of a cart moving down an inclined plane.

The student set up a flat board with a length of 2 meters and a 5° incline. The student then placed a dynamics cart (a metal cart with wheels designed to lessen friction) on the ramp and measured its acceleration using a motion probe. By using the slope of the velocity vs. time graph generated by the motion probe, the student determined the acceleration of the cart.



After the student conducted another trial, the student placed an additional amount of mass on the cart and repeated the procedure. A student generated graph of the data is shown below.



Key	
	Trial 1
	Trial 2

After graphing the data, the student concluded that the mass of the cart does alter the acceleration of the object.

You must address each of the following in your response.

- Identify the **control (if present), constant(s), the dependent variable**, and the **independent variable**.
- Identify the **student mistakes** in the mechanics of the graph.
- Identify and thoroughly discuss the possible **sources of error** resulting from the investigative design.
- Identify and discuss **student mistakes** in the correlation between the **hypothesis**, the **conclusion**, and the **collected data**.
- Identify **two** concepts related to physics dynamics principles that a **high school** student must know to understand this investigation.

? [Help](#)

⦿ [Navigator](#)

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Scoring Rubric for Exercise 1

The **LEVEL 4** response provides *clear, consistent, and convincing* evidence of the ability to evaluate a student-designed investigation, identify the components of the investigation, and analyze a student conclusion concerning the investigation.

Characteristics:

- An accurate and thorough identification of the components of the investigation.
- An accurate and thorough identification of mistakes present in a student work sample.
- An accurate identification and a thorough discussion of possible sources of error in an investigative design.
- An accurate and thorough identification and an informed discussion of student mistakes in the correlation between the student hypothesis, conclusion, and the collected data.
- An accurate and thorough discussion of the science content knowledge that is needed in order to understand the investigation.

The **LEVEL 3** response provides *clear* evidence of the ability to evaluate a student-designed investigation, identify the components of the investigation, and analyze a student conclusion concerning the investigation.

Characteristics:

- An accurate identification of the components of the investigation.
- An accurate identification of mistakes present in a student work sample.
- An accurate identification and a discussion of possible sources of error in the investigative design, although the discussion may not be as thorough as a Level 4 response.
- An accurate identification and an informed discussion of student mistakes in the correlation between the student hypothesis, conclusion, and the collected data, but the discussion is not as informed as a Level 4 response.
- An accurate discussion of the science content knowledge that is needed in order to understand the investigation, although the discussion may not be as detailed as in a Level 4 response.

The **LEVEL 2** response provides *limited* evidence of the ability to evaluate a student-designed investigation, identify the components of the investigation, and analyze a student conclusion concerning the investigation.

Characteristics:

- An incomplete identification of the components of the investigation.
- An incomplete identification of mistakes present in a student work sample.
- An incomplete identification or a limited discussion of possible sources of error in the investigative design.
- An accurate identification but the discussion of student mistakes in the correlation between the student hypothesis, conclusion, and the collected data may only be partially related to the student mistakes, or the identification of student mistakes is incomplete or limited.
- A discussion of the science content knowledge that is needed in order to understand the investigation is limited.

The **LEVEL 1** response provides *little or no* evidence of the ability to evaluate a student-designed investigation, identify the components of an investigation, and analyze a student conclusion concerning the investigation.

Characteristics:


- An inaccurate or missing identification of the components of the investigation.
- An inaccurate or missing identification of mistakes present in a student work sample.
- An inaccurate identification or missing discussion of possible sources of error in the investigative design.
- An inaccurate or missing identification and discussion of student mistakes in the correlation between the student hypothesis, conclusion, and the collected data.
- A discussion of the science content knowledge that is needed in order to understand the investigation is inaccurate or missing.

Sample Exercise 2 and Scoring Rubric

Sample Exercise 2

Standard II. Knowledge of Science / Standard III. Curriculum and Instruction

Exercise 2: Contexts of Science - Candidate Name		⌚ Time Remaining 29:31
Contexts of Science		
<u>Introduction</u>		
<p>In this exercise, you will use your knowledge of science to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society. You will be asked to respond to one prompt.</p>		
<u>Criteria for Scoring</u>		
<p>To satisfy the highest level of the scoring rubric, your response must provide clear, consistent, and convincing evidence of the following:</p>		
<ul style="list-style-type: none">• an accurate and informed description of a major scientific event or discovery;• a thorough and insightful discussion of the scientific knowledge necessary to understand the event or discovery;• an accurate and thorough explanation of how another science discipline is related to the event or discovery; and• an informed description of effects the event or discovery has had on society.		
<u>Directions</u>		
<p>You may view the prompt by clicking the Next button. Compose your response in the space provided.</p>		
? Help	⌚ Navigator	Next →

Exercise 2: Contexts of Science - Candidate Name		 Time Remaining 29:31
<p>In 1897, J. J. Thompson discovered the electron, measured its charge-to-mass ratio, and set the stage for the exploration of the fundamental pieces of the atom. It fell to a professor at the University of Chicago named Robert Millikan to measure the actual charge on the electron. Although there have been allegations of misconduct in his work, Millikan's oil-drop experiment is still one of the most elegant joinings of simple physics principles to date.</p> <p>By spraying charged oil drops with a perfume atomizer, Millikan was able to suspend oil in midair using a variable electric field. Balancing the electrical force on the drop with the force of gravity allowed him to accurately measure the charge placed on the oil. A graphical analysis of many labor-intensive experiments showed that the charge on various drops came in packets, or quanta. This stepwise function gave him the charge on the electron.</p> <p>After publishing his work in 1910 and publishing additional data in 1913, Millikan was awarded the Nobel Prize in Physics in 1923 (for this work as well as for determining the value of Planck's constant). Scientists have since looked at his notebooks and discovered that in those crucial years of his experimentation, he omitted several trials that did not yield what he considered valid results.</p>		
<p>You must address each of the following in your response.</p> <ul style="list-style-type: none">• Discuss the scientific event or discovery.• Discuss the science knowledge necessary to understand the event or discovery.• Explain how a science discipline other than physics is related to the event or discovery.• Describe two effects the event or discovery has had on society.		
? Help	⦿ Navigator	Next →

Scoring Rubric for Exercise 2

The **LEVEL 4** response provides *clear, consistent, and convincing* evidence of the ability to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society.

Characteristics:

- An accurate and thorough description of a major scientific event or discovery.
- A thorough and insightful discussion of the scientific knowledge necessary to understand the event or discovery.
- An accurate and thorough explanation of how another science discipline is related to the event or discovery.
- A thorough description of how the event or discovery has affected society.

The **LEVEL 3** response provides *clear* evidence of the ability to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society.

Characteristics:

- An accurate and informed description of a major scientific event or discovery.
- A thorough and complete discussion of the scientific knowledge necessary to understand the event or discovery, although the discussion may not be as thorough as a Level 4 response.
- An accurate and complete explanation of how another science discipline is related to the event or discovery, but the discussion is not as informed as a Level 4 response.
- An informed description of how the event or discovery has affected society, although the discussion may not be as detailed as in a Level 4 response.

The **LEVEL 2** response provides *limited* evidence of the ability to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society.

Characteristics:

- An incomplete description of a major scientific event or discovery.
- An incomplete discussion of the scientific knowledge necessary to understand the event or discovery.
- An incomplete explanation of how another science discipline is related to the event or discovery.
- An incomplete description of how the event or discovery has affected society.

The **LEVEL 1** response provides *little or no* evidence of the ability to describe a scientific event or discovery and discuss the scientific knowledge needed to understand the event or discovery, explain how another science discipline is related to the event or discovery, and describe how the event or discovery has affected society.

Characteristics:

- An inaccurate or missing description of a major scientific event or discovery.
- An inaccurate or missing discussion of the scientific knowledge necessary to understand the event or discovery.
- An inaccurate or missing explanation of how another science discipline is related to the event or discovery.
- An inaccurate or missing description of how the event or discovery has affected society.

Sample Exercise 3 and Scoring Rubric

Sample Exercise 3

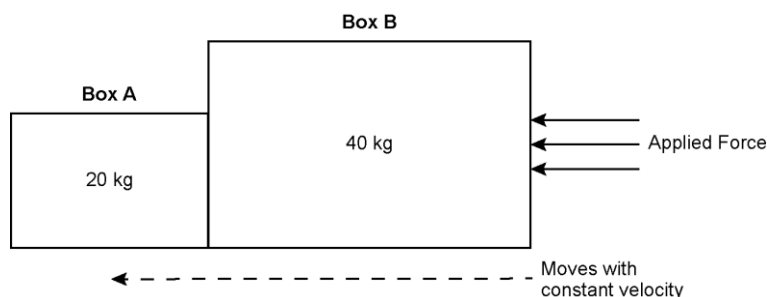
Standard II. Knowledge of Science / Standard III. Curriculum and Instruction /
Standard IV. Assessment

Exercise 3: Development of Scientific Concepts - Candidate Name		⌚ Time Remaining 29:31
Development of Scientific Concepts		
<u>Introduction</u>		
<p>In this exercise, you will demonstrate your knowledge of scientific conceptual development by evaluating and describing a student's conceptual understanding of scientific concepts, and by describing instruction that would help move the student toward the accepted understanding of the scientific concept. You will be asked to respond to one prompt.</p>		
<u>Criteria for Scoring</u>		
<p>To satisfy the highest level of the scoring rubric, your response must provide clear, consistent, and convincing evidence of the following:</p>		
<ul style="list-style-type: none">• an accurate evaluation of a student's conceptual understanding through examination of the student's work;• an accurate description of two scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding; and• an informed description of the instruction you would use to address the student's conceptual understanding.		
<u>Directions</u>		
<p>You may view the prompt by clicking the Next button. Compose your response in the space provided.</p>		
? Help	⌚ Navigator	Next →

Exercise 3: Development of Scientific Concepts -
Candidate Name

 Time Remaining
29:31

Students were asked to describe the horizontal forces acting on the boxes in the diagram. The diagram shows two boxes as they are pushed horizontally with a constant velocity to the left, along a flat, rough patch of ground.



Student Response: Both of the boxes are sliding to the left against the rough ground, so there must be friction acting to the right on the boxes. The total friction acting on both boxes must be less than the applied force because the boxes are moving to the left. Also, Box A pushes to the right on Box B, and Box B pushes to the left on Box A. Box B pushes harder on Box A than Box A pushes on Box B, because Box B is moving Box A to the left and because Box B is heavier.

You must address each of the following in your response.

- Evaluate the student's conceptual understanding.
- Describe in detail **two** scientific concepts the student would need to understand in order to move toward the accepted scientific understanding of the concept.
- Briefly describe what you would do next in an instructional context to address the student's conceptual understanding.

? [Help](#)

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Scoring Rubric for Exercise 3

The **LEVEL 4** response provides *clear, consistent, and convincing* evidence of the ability to evaluate and describe a student’s conceptual understanding of scientific concepts, and to describe instruction that would help move the student toward the accepted understanding of the scientific concept.

Characteristics:

- An accurate and thorough identification of a student’s conceptual understanding through examination of the student’s work.
- An accurate and thorough description of the scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding.
- An informed and thorough description of the instruction you would use to address the student’s conceptual understanding.

The **LEVEL 3** response provides *clear* evidence of the ability to evaluate and describe a student’s conceptual understanding of scientific concepts, and to describe instruction that would help move the student toward the accepted understanding of the scientific concept.

Characteristics:

- An accurate identification of a student’s conceptual understanding through examination of the student’s work.
- An accurate description of the scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding, although the description may not be as thorough as a Level 4 response.
- An informed description of the instruction you would use to address the student’s conceptual understanding, although the description may not be as thorough as a Level 4 response.

The **LEVEL 2** response provides *limited* evidence of the ability to evaluate and describe a student's conceptual understanding of scientific concepts, and to describe instruction that would help move the student toward the accepted understanding of the scientific concept.

Characteristics:

- An incomplete identification of a student's conceptual understanding through examination of the student's work.
- An incomplete description of the scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding.
- An incomplete description of the instruction you would use to address the student's conceptual understanding.

The **LEVEL 1** response provides *little or no* evidence of the ability to evaluate and describe a student's conceptual understanding of scientific concepts, and to describe instruction that would help move the student toward the accepted understanding of the scientific concept.

Characteristics:

- An inaccurate or missing identification of a student's conceptual understanding through examination of the student's work.
- An inaccurate or missing description of the scientific concepts the student would need to understand in order to move toward the accepted scientific conceptual understanding.
- An inaccurate or missing description of the instruction you would use to address the student's conceptual understanding.

Reference Material for AYA/Science: Physics Component 1

This section includes the following about resources provided as part of the assessment:

- information about the online scientific calculator
- constants
- periodic table

Calculator Information

An online scientific calculator is available to you for this test. It is similar to the Texas Instruments handheld TI-30XS scientific calculator.

To access the calculator, click on the calculator icon located in the upper left corner of the screen. A pop-up window containing the calculator will appear. You can reposition the calculator by placing your cursor in the blue area above the calculator and dragging the window to the location of your choice.

Use the numbers on the keyboard and/or point and click with the mouse to enter your computations into the on-screen calculator. When you are finished, close the calculator by clicking the button in the upper right corner of the calculator.

Constants

CONSTANTS

Description	Value
Acceleration of gravity on Earth (g)	9.80 m/s ²
Speed of light in a vacuum (c)	3.00×10^8 m/s
Planck's constant (h)	6.63×10^{-34} J•s = 4.14×10^{-15} eV•s
Electron rest mass	9.11×10^{-31} kg
Proton rest mass	1.67×10^{-27} kg
Charge of electron	-1.60×10^{-19} C
Coulomb's constant (k_e)	9.0×10^9 N•m ² /C ²
Boltzmann's constant (k)	1.38×10^{-23} J/K
Gas constant (R)	8.31 J/(mol•K)
Gravitational constant (G)	6.67×10^{-11} N•m ² /kg ²
Permeability of free space (μ_0)	$4\pi \times 10^{-7}$ T•m/A
Avogadro's number	6.02×10^{23} particles/mole
Specific heat (s) of water (liquid)	4.184 J/(g•K) = 4.184 J/(g•°C) = 1.0 cal/(g•°C)
Heat of fusion of water (ΔH_{fus})	334 J/g = 80 cal/g = 6.01 kJ/mol
Heat of vaporization of water (ΔH_{vap})	2260 J/g = 540 cal/g = 40.7 kJ/mol

Angle (θ)	$\sin\theta$	$\cos\theta$	$\tan\theta$
30°	0.500	0.866	0.577
45°	0.707	0.707	1.00
60°	0.866	0.500	1.73

NOTES FOR ADOLESCENCE AND YOUNG ADULTHOOD SCIENCE (PHYSICS) TEST

Not all constants necessary are listed, nor are all constants listed used on this test.

While attention has been paid to significant figures, no answer should be considered incorrect solely because of the number of significant figures.

Periodic Table

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1A	2A							8B		1B	2B	3A	4A	5A	6A	7A	8A
1 H 1.01	2 He 4.00	3 Li 6.94	4 Be 9.01	5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18	11 Na 23.0	12 Mg 24.3	13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 39.9
19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc 99.9	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57-71 Lanthanide Series	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po 209.0	85 At 209.0	86 Rn 222.0
87 Fr	88 Ra	89-103 Actinide Series	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Lv	116 Lv	117 Ts	118 Og

57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
89 Ac	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Elements 113, 115, 117, and 118 have been reported, but they have not yet been named by the IUPAC.
Standard atomic weight values are not listed for elements with no stable isotopes.
Conventional atomic weights have been provided for B, C, Cl, H, Li, N, O, Si, S, and Ti.

Produced for

NATIONAL BOARD

for Professional Teaching Standards®

by



Pearson

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