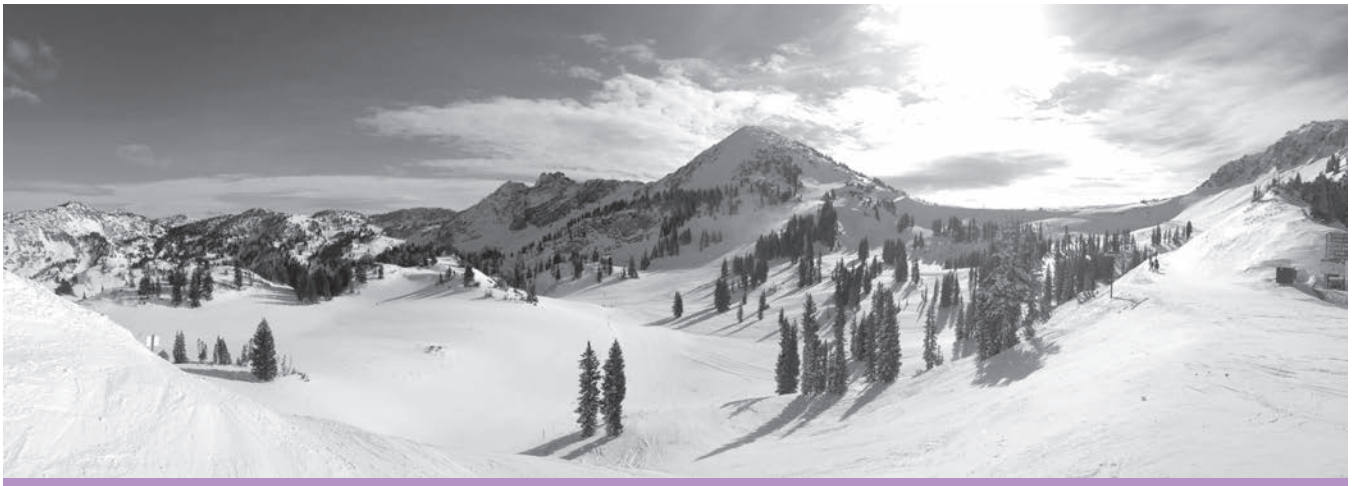
Colorado Measures of Academic Success



Grade 11 Science

Answer Key with Scoring Rubrics, Sample Responses & Annotations

Practice Resource for Students

1148285 1 2 3 4 5 A B C D E Printed in the USA ISD37553

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ITEM INFORMATION

Colorado Academic Standard (CAS) Evidence Outcome

Describes the evidence that demonstrates that a student is meeting the grade level expectation at a mastery level.

Disciplinary Core Ideas

The Disciplinary Core Ideas (DCIs) form the basis for the content that students are expected to know by the end of the grade level and are present in every item.

Science and Engineering Practices

The Science and Engineering Practices (SEPs) in the CAS are interwoven within certain items, and all SEPs are assessed according to the SEP progressions. The SEP is the first few words of the Evidence Outcome. If an SEP is not present in an item, then the item will not ask the student to demonstrate knowledge of the first part of the Evidence Outcome.

Crosscutting Concepts

Crosscutting concepts (CCCs) have applications across all domains of science. As such, they are a way of linking the different domains of science. The CCCs in the CAS are interwoven within certain items. Each CCC found in the CAS is assessed according to the CCC progressions.

Scenarios for Items

Items are driven by high-quality scenarios that are grounded in phenomena or problems. All scenarios are puzzling and intriguing and are explainable using grade appropriate integration of the three dimensions of the 2020 CAS. Scenarios are presented in three ways: simulations, clusters, and standalone items.

Simulations

Students are presented with an interactive simulation of a science model or experiment and asked to make sense of the observed phenomenon. They answer multiple two- or three-dimensional questions related to the content using their knowledge of the 2020 CAS.

Clusters

Students are presented with background information, still images, graphs, tables, and additional media and asked to make sense of the described phenomenon. Using their knowledge of the 2020 CAS, they answer multiple two- or three-dimensional questions related to the content.

Standalone Items

Students are presented with a unique phenomenon and asked to make sense of that phenomenon based on the information in the stimulus. They answer the two- or three-dimensional question using their knowledge of the 2020 CAS.

Simulation and cluster scenarios comprise the majority of the assessment as students are asked to make sense of a larger phenomenon and answer questions associated with those scenarios. Standalone items are included only to target a small number of 2020 CAS Evidence Outcomes not represented in simulation and cluster scenarios. These Evidence Outcomes rotate on an annual basis.

ITEM TYPES

Items are questions that appear on the assessments. They are presented in three different ways.

Selected Response (Multiple Choice, Multiple Response, and Fill in the Blank)

For multiple choice and multiple response items, students select a correct answer out of provided choices. For fill in the blank items, students type/write their answer in a blank box.

Technology-Enhanced (Bar Graph, Drag and Drop, Inline Choice, Hot Spot, and Match Table Grid)

Students show their answer using technology, such as by creating a bar graph using a template provided by the online testing system or on the paper-based test. Drag and drop items require students to drag answer choices into correct answer bays (draw lines or write corresponding letters for paper-based testing). Inline choice items require students to select their answer from a drop-down menu (circle answer from a list of choices for paper-based testing) to complete a sentence or sentences. Hot spot items require students to select the correct response from its location in an image (write corresponding letters or circle answer for paper-based testing). Match table grid items require students to check checkboxes in cells to indicate a match between the column and row labels.

Constructed Response

Students construct an open-ended response.

STUDENT PERFORMANCE

P Value – Selected Response and Technology-Enhanced Only

The P value represents the percentage of students who answered each selected response and technology-enhanced question correctly. For example, if the P value associated with a question is 0.64, then 64% of students responded to the question with the correct answer.

Score Point Distribution – Constructed Response Only

The score point distribution provides the percentage of students who scored at each possible score point for constructed response questions.

Sample Student Responses and Annotations – Constructed Response Only

Sample student responses are provided at each score point for constructed response items. Sample responses include annotations that provide reasoning for the score. Scoring rubrics are provided for constructed response items.

Note: P values and score point distributions are only available for released items (i.e., questions that previously appeared on CMAS assessments administered statewide). Items without this information were developed as sample items.

ANSWER KEY: ITEM SET 1

Item Set 1 – Question 1 (Multiple Select)

A student drops objects of different masses to measure force. The student uses objects with these masses: 1 kilogram (kg), 10 kg, and 20 kg. The student drops each object from a height of 10 meters. All the objects take the same amount of time to fall. The resulting data are shown in the table.

Mass and Force Data

Object	Mass (kg)	Force (newtons)
W	1	9.8
X	10	98
Y	20	196

The student claims that the data support Newton's Second Law of Motion.

Newton's Second Law of Motion

The force acting on an object causes it to accelerate according to this formula

$$F = m \cdot a$$

where

F = force, in newtons (N)

m = mass, in kilograms (kg)

a = acceleration, in meters per second squared (m/s^2)

Select the **two** pieces of evidence from the investigation that support the student's claim.

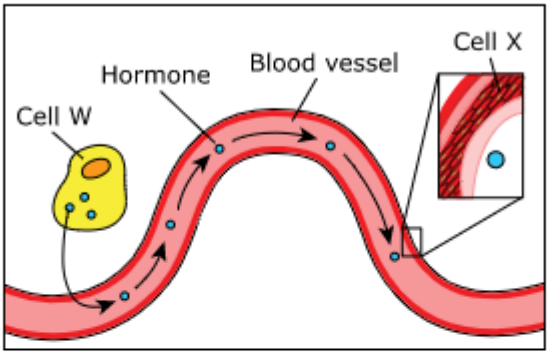
- ☐ A. Each object exerts the same force on Earth as Earth exerts on the object.
- ☐ B. Each object starts to move only after a force is applied to it.
- ☑ C. The forces are all in proportion to the masses they affect.
- ☐ D. The objects are all dropped from the same height.
- ☑ E. The objects all accelerate at the same rate.

Item Information

- Answer – C, E
- Standard – Physical Science
- Evidence Outcome – SC.HS.1.4.a
    - Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
- Disciplinary Core Idea – SC.HS.1.4
    - Newton's second law and the conservation of momentum can be used to predict changes in the motion of macroscopic objects.
- Science and Engineering Practice – Analyzing and Interpreting Data
    - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
- Crosscutting Concept – Cause and Effect

Item Set 1 – Question 2 (TEI Inline Choice)

Study the model of hormone interactions.



Select one correct response from each drop-down menu to complete the sentences.

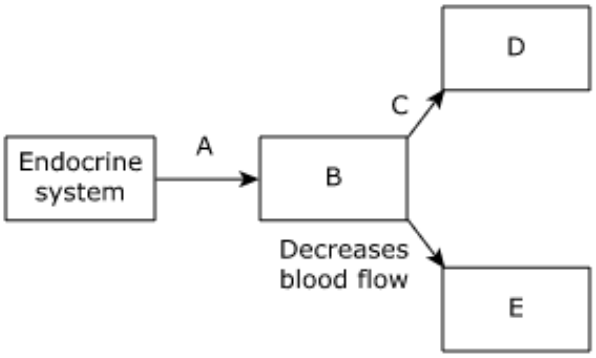
This model shows steps 1 and 2 of the process described in Part 1. In the model, the hormone is released by Cell W, which is part of the [endocrine] system. The hormone leaves the circulatory system and binds to Cell X in [muscle tissue] that [changes shape to dilate vessels].

Item Information

- Answer – See Image
- Standard – Life Science
- Evidence Outcome – SC.HS.2.1.b
  - Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- Disciplinary Core Idea – SC.HS.2.1
  - DNA codes for the complex hierarchical organization of systems that enable life's functions.
- Science and Engineering Practice – Developing and Using Models
  - Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.
- Crosscutting Concept – Systems and System Models

Item Set 1 – Question 3 (TEI Drag and Drop)

Model of Some Actions of the Endocrine System



One body system and one action are labeled in the model. Use the information and steps in Part 1 to develop the model.

Drag each letter from the model into the table to label the step or body system. Each letter may be used once.

Letter	Step or Body System
A	Step 1
C	Step 3
E	nervous system
D	digestive system
B	circulatory system

Item Information

- Answer – See Image
- Standard – Life Science
- Evidence Outcome – SC.HS.2.1.b
  - Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- Disciplinary Core Idea – SC.HS.2.1
  - DNA codes for the complex hierarchical organization of systems that enable life's functions.
- Science and Engineering Practice – Developing and Using Models
  - Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.
- Crosscutting Concept – Systems and System Models

Item Set 1 – Question 4 (Selected Response)

A student wants to add a fifth step to the digestion process described in Part 1 to help explain one reason why people might feel tired after eating.

Based on the information provided, which statement should be Step 5 of the digestion process?

- ○ A. More blood flows to the endocrine system.
- ○ B. Less blood flows to the endocrine system.
- ○ C. More blood flows to the nervous system.
- ◉ D. Less blood flows to the nervous system.

Item Information

- Answer – D
- Standard – Life Science
- Evidence Outcome – SC.HS.2.1.c
  - Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- Disciplinary Core Idea – SC.HS.2.1
  - DNA codes for the complex hierarchical organization of systems that enable life's functions.
- Science and Engineering Practice – Developing and Using Models
  - Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.
- Crosscutting Concept – Systems and System Models

Item Set 1 – Question 5 (Constructed Response)

A group of students discusses ideas for the frequency of data collection in the investigation described in Part 2. They come up with three possible plans.

- Plan A: Collect data 1 hour before, 10 minutes before, immediately before, and immediately after eating.
- Plan B: Collect data immediately before eating and immediately after eating.
- Plan C: Collect data immediately before, immediately after, 10 minutes after, and 1 hour after eating.

Determine which plan will give the students the most usable data. Your response should include:

- the plan that will provide the best evidence for the effect of feedback loops on homeostasis
- why this plan will provide the best evidence for the effect of feedback loops on homeostasis

Item Information

- Answer – See Scoring Rubric and Sample Student Responses
- Standard – Life Science
- Evidence Outcome – SC.HS.2.1.b
  - Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
- Disciplinary Core Idea – SC.HS.2.1
  - DNA codes for the complex hierarchical organization of systems that enable life's functions.
- Science and Engineering Practice – Planning and Carrying Out Investigations
  - Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.
- Crosscutting Concept – Stability and Change

Points	Attributes
2	**The student's response should include:** • The plan that will provide the best evidence for the effect of feedback loops on homeostasis. • Why this plan will provide the best evidence for the effect of feedback loops on homeostasis. **Student responses may include but are not limited to:** • Plan C will provide the best evidence for the effect of feedback loops on homeostasis. • Plan C will provide more data than Plan B and will provide more useful data than Plan A; collecting data one hour after eating is more valuable for evaluating changes in body systems resulting from the digestion process and how those changes are regulated by interactions among body systems to restore balance.
1	Student response demonstrates a partial understanding of the task.
0	Student response does not demonstrate an understanding of the task.

Sample Student Reponses

Sample student responses are not representative of all correct answers for an item and are provided only as a guide to assist teachers with scoring.

Points – Sample Response and Annotation

2 – Sample Response and Annotation

- **Sample Response**
  - Plan C will provide the best evidence for the effect of feedback loops on homeostasis.

    Plan C will provide more data than Plan B and will provide more useful data than Plan A; collecting data one hour after eating is more valuable for evaluating changes in body systems resulting from the digestion process and how those changes are regulated by interactions among body systems to restore balance.
- **Sample Annotation**
  - This response demonstrates a complete understanding of the task. The student clearly states which plan will provide the best evidence (*Plan C will provide the best evidence*) and explains why Plan C is the best choice for providing evidence for the effect of the feedback loop on homeostasis (*Plan C will provide more data than Plan B and will provide more useful data than Plan A; collecting data one hour after eating is more valuable*).

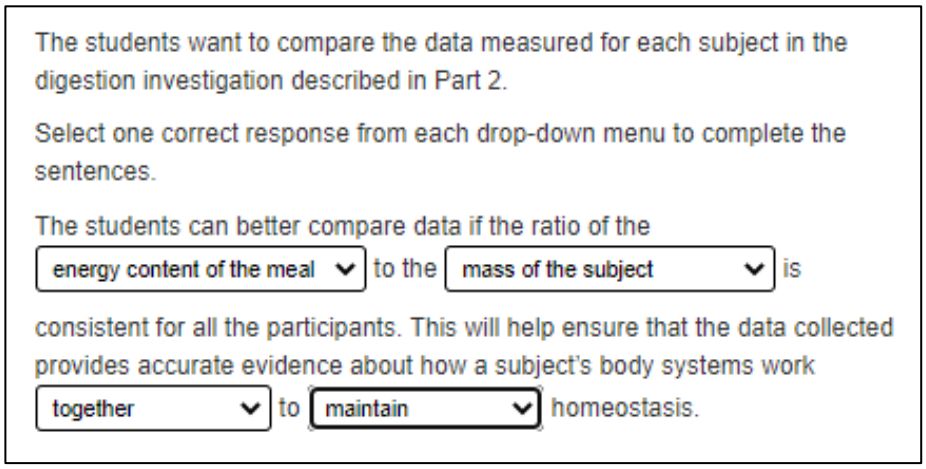
1 – Sample Response and Annotation

- **Sample Response**
  - The plan that tests before eating, immediately after, ten minutes after, and 1 hour after eating will provide the best evidence for the effect of feedback loops on homeostasis.
- **Sample Annotation**
  - This response demonstrates a partial understanding of the task. The student indicates which plan will provide the best evidence (The plan that tests before eating, immediately after, ten minutes after, and 1 hour after eating). Even though the student does not directly state a plan by letter, it is clear this is the data collection schedule that corresponds to Plan C. No explanation is given as to why this plan would provide the best evidence for the effect of feedback loops on homeostasis.

0 – Sample Response and Annotation

- **Sample Response**
  - The plan that collects data immediately before and immediately after the meal will be the best.
- **Sample Annotation**
  - This response does not demonstrate an understanding of the task. The incorrect plan is indicated, and no explanation is provided.

Item Set 1 – Question 6 (TEI Inline Choice)



Item Information

- Answer – See Image
- Standard – Life Science
- Evidence Outcome – SC.HS.2.1.c
  - Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
- Disciplinary Core Idea – SC.HS.2.1
  - DNA codes for the complex hierarchical organization of systems that enable life's functions.
- Science and Engineering Practice – Planning and Carrying Out Investigations
  - Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.
- Crosscutting Concept – Stability and Change

Item Set 1 – Question 7 (Selected Response)

Giant pandas and red pandas both eat bamboo and have a modified wrist bone that functions like a thumb to help the animals grip bamboo while eating. A student claims that giant pandas and red pandas must be related because of these similarities.

Which of the following investigations would provide the **best** evidence to support or refute the student's claim?

- A. a comparison of the anatomical structures of the leg bones of giant pandas and red pandas
- B. a comparison of DNA patterns in the genomes of giant pandas and red pandas
- C. a comparison of the fossilized ancestors of giant pandas and red pandas
- D. a comparison of the behaviors of giant pandas and red pandas

Item Information

- Answer – B
- Standard – Life Science
- Evidence Outcome – SC.HS.2.10.a
    - Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. (HS-LS4-1) (Clarification Statement: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development.) |SEP 8 OECI|CCC 1 P |
- Disciplinary Core Idea – SC.HS.2.10
    - Evidence of common ancestry and diversity between species can be determined by examining variations including genetic, anatomical and physiological differences.
- Science and Engineering Practice – Not assessed in this item.
- Crosscutting Concept – Patterns
- P Value – 0.624

Item Set 1 – Question 8 (TEI Multiple Select)

Two engineers are discussing whether a wind turbine should be placed in Location B. Based on the information in Part 1, determine whether each statement supports placing the wind turbine at Location B or at a different location.

Select **one** box per row.

Statement	Supports Placing the Wind Turbine at Location B	Supports Placing the Wind Turbine at a Different Location
The distance between the power source and the community using the power is minimal, which reduces the cost to transmit the power.	☑	☐
Additional access roads do not have to be constructed, which will conserve wildlife habitats.	☑	☐
The wind turbines generate low-frequency noise, which may interrupt people's sleep.	☐	☑

Item Information

- Answer – See Image
- Standard – Earth and Space Science
- Evidence Outcome – SC.HS.3.9.b
    - Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. (HS-ESS3-2) (Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources [such as minerals and metals] where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining [for coal, tar sands, and oil shales] and pumping [for petroleum and natural gas]. Science knowledge indicates what can happen in natural systems – not what should happen.) |SEP 7 EAE|CCC N/A|
- Disciplinary Core Idea – SC.HS.3.9
    - Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
- Science and Engineering Practice – Engaging in Argument from Evidence
    - Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations).
- Crosscutting Concept – CCC Not Assessed

Item Set 1 – Question 9 (Constructed Response)

Distributed wind systems (DWS) are networks of individual turbines that power homes or businesses. A business builds a wind turbine and uses it to power a specific location. This location will then contribute any excess energy to the community power grid for others to use. The DWS can be far away from the places that it powers.

The people working in locations A, B, C, and D all use the same power grid, but use of DWS might affect them differently.

Based on the information, identify the location that would benefit the most from a DWS and explain why. Your response should include:

- identification of which location would benefit the most from a DWS rather than the installation of a local set of wind turbines
- why that location is the best selection for the DWS

Item Information

- Answer – See Scoring Rubric and Sample Student Responses
- Standard – Earth and Space Science
- Evidence Outcome – SC.HS.3.9.b
    - Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. (HS-ESS3-2) (Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources [such as minerals and metals] where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining [for coal, tar sands, and oil shales] and pumping [for petroleum and natural gas]. Science knowledge indicates what can happen in natural systems – not what should happen.) |SEP 7 EAE|CCC N/A|
- Disciplinary Core Idea – SC.HS.3.9
    - Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
- Science and Engineering Practice – Engaging in Argument from Evidence
    - Construct, use, and/or present an oral and written argument or counter arguments based on data and evidence.
- Crosscutting Concept – CCC Not Assessed

Points	Attributes
2	**The student's response should include:** • Identification of which location would benefit the most from a DWS rather than the installation of a local set of wind turbines. • Why that location is the best selection for the DWS. **Student responses may include but are not limited to:** Location C would benefit the most from the DWS because the energy generation from a wind turbine is lowest at this location. A DWS would allow people at this location to benefit from wind turbines even though local wind turbines would not be efficient.
1	Student response demonstrates a partial understanding of the task.
0	Student response does not demonstrate an understanding of the task.

Sample Student Reponses

Sample student responses are not representative of all correct answers for an item and are provided only as a guide to assist teachers with scoring.

Points – Sample Response and Annotation

2 – Sample Response and Annotation

- **Sample A Response**
  - Location C would benefit the most because they can't produce as much wind where they are and so it would be better for them to have the wind turbine somewhere that can produce more.
- **Sample A Annotation**
  - The response identifies a location that would benefit the most from a DWS rather than the installation of a local set of wind turbines (*Location C*).
  - The response explains why that location is the best selection for the DWS (*they can't produce as much wind where they are and so it would be better for them to have the wind turbine somewhere that can produce more*).
- **Sample B Response**
  - Location C would benefit the most because the wind turbine has a high impact on the ecosystem in this location. I think this is near a bird sanctuary and the people who live and work here would not want to have a wind turbine near them, where it could kill endangered species. They would rather put it in location D where it is safer but they can still use the energy it generates.
- **Sample B Annotation**
  - The response identifies a location that would benefit the most from a DWS rather than the installation of a local set of wind turbines (*Location C*).
  - The response explains why that location is the best selection for the DWS (*high impact on the ecosystem in this location … where it could kill endangered species*).

1 – Sample Response and Annotation

- **Sample A Response**
  - Location C because it says "low, high, medium, low."
- **Sample A Annotation**
  - The response identifies a location that would benefit the most from a DWS rather than the installation of a local set of wind turbines (*Location C*).
  - The response does not explain why that location is the best selection for the DWS. Citing data from the text without explaining how it supports the selection of location C does not receive credit.
- **Sample B Response**
  - Location C
- **Sample B Annotation**
  - The response identifies a location that would benefit the most from a DWS rather than the installation of a local set of wind turbines (*Location C*).
  - The response does not explain why that location is the best selection for the DWS.

0 – Sample Response and Annotation

- **Sample A Response**
  - Location B because that is where the most people are.
- **Sample A Annotation**
  - The response does not identify a location that would benefit the most from a DWS rather than the installation of a local set of wind turbines.
  - The response does not explain why that location is the best selection for the DWS.
- **Sample B Response**
  - Location A because it is pretty in the mountains and a windmill would look nice there.
- **Sample B Annotation**
  - The response does not identify a location that would benefit the most from a DWS rather than the installation of a local set of wind turbines.
  - The response does not explain why that location is the best selection for the DWS. This response gives a reason why a local wind turbine could be a benefit in the chosen location.

Item Set 1 – Question 10 (Selected Response)

The community builds multiple wind turbines at Location A. Why has the community **most likely** chosen Location A to install wind turbines?

- ○ A. The location is the most accessible for building large structures.
- ○ B. The location is the closest to a major metropolitan area.
- ◉ C. The location has a high availability of wind resources.
- ○ D. The location has the lowest environmental impact.

Item Information

- Answer – C
- Standard – Earth and Space Science
- Evidence Outcome – SC.HS.3.9.a
    - Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. **(HS-ESS3-1) (Clarification Statement: Examples of key natural resources include access to fresh water [such as rivers, lakes, and groundwater], regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes [such as volcanic eruptions and earthquakes], surface processes [such as tsunamis, mass wasting, and soil erosion], and severe weather [such as hurricanes, floods, and droughts]. Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.) |SEP 6 CEDS|CCC 2 CAE|**Also assessed as SC.HS.3.10.a under GLE SC.HS.3.10.
- Disciplinary Core Idea – SC.HS.3.9
    - Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
- Science and Engineering Practice – Not assessed in this item.
- Crosscutting Concept – Cause and Effect

Item Set 1 – Question 11 (TEI Inline Choice)

Large rotors are often difficult and costly to transport. Despite the transportation costs, the general trend in wind energy is to utilize larger rotors. Based on the data in the table in Part 2, what is an explanation for the trend to use larger rotors?

Select one correct response from each drop-down menu to complete the sentences.

Using larger rotors means [fewer] turbines are needed, on average, to meet electricity production goals. This ultimately leads to [lower] long-term costs.

Because different locations vary in average wind speed, peak wind speed, and a variety of other conditions, the trend toward larger rotors will [not be universal].

Item Information

- Answer – See Image
- Standard – Earth and Space Science
- Evidence Outcome – SC.HS.3.9.b
    - Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. (HS-ESS3-2) (Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources [such as minerals and metals] where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining [for coal, tar sands, and oil shales] and pumping [for petroleum and natural gas]. Science knowledge indicates what can happen in natural systems - not what should happen.) |SEP 7 EAE|CCC N/A|
- Disciplinary Core Idea – SC.HS.3.9
    - Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
- Science and Engineering Practice – Engaging in Argument from Evidence
    - Evaluate competing design solutions based on jointly developed and agreed upon design criteria.
- Crosscutting Concept – CCC Not Assessed

Item Set 1 – Question 12 (Constructed Response)

The cost to transport wind turbine construction materials increases with distance. An engineer compares the options of using a wind turbine with a 120 m diameter rotor at either Location C or Location D. The materials would be transported from Location B. Based on this information and the results of Part 1, explain why Location D would provide the better long-term cost-benefit result regarding transportation cost and electricity production. Your answer should include:

- a comparison between the long-term effects of higher transportation costs and the long term benefit of greater electricity production
- an explanation of how this comparison favors Location D instead of Location C

Item Information

- Answer – See Scoring Rubric and Sample Student Responses
- Standard – Earth and Space Science
- Evidence Outcome – SC.HS.3.9.b
    - Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. (HS-ESS3-2) (Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources [such as minerals and metals] where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining [for coal, tar sands, and oil shales] and pumping [for petroleum and natural gas]. Science knowledge indicates what can happen in natural systems - not what should happen.) |SEP 7 EAE|CCC N/A|
- Disciplinary Core Idea – SC.HS.3.9
    - Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
- Science and Engineering Practice – Engaging in Argument from Evidence
    - Construct, use, and/or present an oral and written argument or counter arguments based on data and evidence.
- Crosscutting Concept – CCC Not Assessed

Points	Attributes
2	**The student's response should include:** • A comparison between the long-term effects of higher transportation costs and the long term benefit of greater electricity production. • An explanation of how this comparison favors Location D instead of Location C. **Student responses may include but are not limited to:** Transportation costs occur only once, while electricity production continues over time. So in the long term, greater electricity production is more important than higher transportation costs. Therefore, because Location D has greater electricity production, it is the better choice even though it is farther from Location B and will have higher transportation costs.
1	Student response demonstrates a partial understanding of the task.
0	Student response does not demonstrate an understanding of the task.

Sample Student Reponses

Sample student responses are not representative of all correct answers for an item and are provided only as a guide to assist teachers with scoring.

Points – Sample Response and Annotation

2 – Sample Response and Annotation

- **Sample A Response**
  - It will cost more to transport the wind turbine to D than to C, but in the long term it will produce so much more energy that it will be worth the expense. A windmill is made to last for years, so after a few years of not having to buy fossil fuels, it will pay for itself. The chart says that the energy output at C is low and at D is high.
- **Sample A Annotation**
  - The response provides a comparison between the long-term effects of higher transportation costs and the long term benefit of greater electricity production (*after a few years of not having to buy fossil fuels, it will pay for itself. The chart says that the energy output at C is low and at D is high*). The response does not explicitly state that transportation is a one-time expense, but it is clear from the context that this is understood.
  - The response gives an explanation of how this comparison favors Location D instead of Location C (*It will cost more to transport the wind turbine to D than to C, but in the long term it will produce so much more energy that it will be worth the expense*).
- **Sample B Response**
  - If the windmill is running for 10 years and at location D and makes $2000 more a year in electricity than a windmill in location C and it cost $10,000 extra to transport it to location D, then that is a savings of $10000 over 10 years.
- **Sample B Annotation**
  - The response provides a comparison between the long-term effects of higher transportation costs and the long term benefit of greater electricity production (*$2000 more a year in electricity than a windmill in location B and it cost $10,000 extra to transport it*). Calling the wind turbine a "windmill" is acceptable.
  - The response gives an explanation of how this comparison favors Location D instead of Location C (*then that is a savings of $10000 over 10 years*). Using theoretical numbers is acceptable.

1 – Sample Response and Annotation

- **Sample A Response**
  - You only pay for transportation once but you get the electricity from it year after year, so it is more important to get more electricity.
- **Sample A Annotation**
  - The response provides a comparison between the long-term effects of higher transportation costs and the long term benefit of greater electricity production (*You only pay for transportation once but you get the electricity from it year after year, so it is more important to get more electricity*).

- The response does not give an explanation of how this comparison favors Location D instead of Location C.

- **Sample B Response**
  - Location D is better because it says you get high energy output so you will be getting more bang for your buck in the long term.
- **Sample B Annotation**
  - The response gives an explanation of how this comparison favors Location D instead of Location C (*Location D is better because it says you get high energy output so you will be getting more bang for your buck in the long term*).
  - The response does not provide a comparison between the long-term effects of higher transportation costs and the long term benefit of greater electricity production.

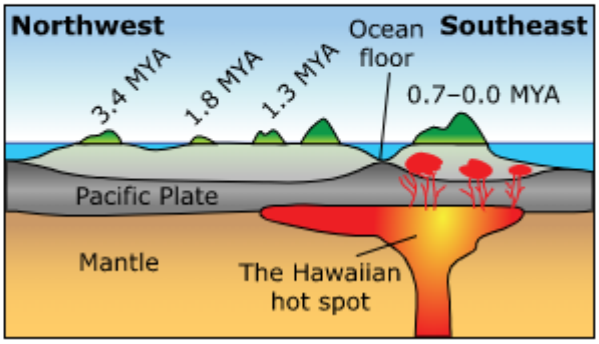
0 – Sample Response and Annotation

- **Sample A Response**
  - Location C is better because if you don't have money for transportation you can't even build a wind turbine.
- **Sample A Annotation**
  - The response does not provide a comparison between the long-term effects of higher transportation costs and the long term benefit of greater electricity production.
  - The response does not give an explanation of how this comparison favors Location D instead of Location C.
- **Sample B Response**
  - I would pick location D.
- **Sample B Annotation**
  - The response does not provide a comparison between the long-term effects of higher transportation costs and the long term benefit of greater electricity production
  - The response does not give an explanation of how this comparison favors Location D instead of Location C

ANSWER KEY: ITEM SET 2

Item Set 2 – Question 1 (Selected Response)

The diagram shows the Hawaiian hot spot and the ages at which some Hawaiian islands were formed millions of years ago (MYA). The oldest island shown is Oahu, which formed 3.4 MYA, while the youngest is Hawaii, which formed between 0.7 and 0.0 MYA.



not to scale

Based on the information in the diagram, which statement explains how the islands that are **not** directly over the Hawaiian hot spot formed?

- A. The Hawaiian hot spot moved to the northwest, causing lava to move along the ocean floor.
- B. The Hawaiian hot spot moved to the southeast, causing lava to move along the ocean floor.
- C. The Pacific Plate moved to the northwest, over the Hawaiian hot spot.
- D. The Pacific Plate moved to the southeast, over the Hawaiian hot spot.

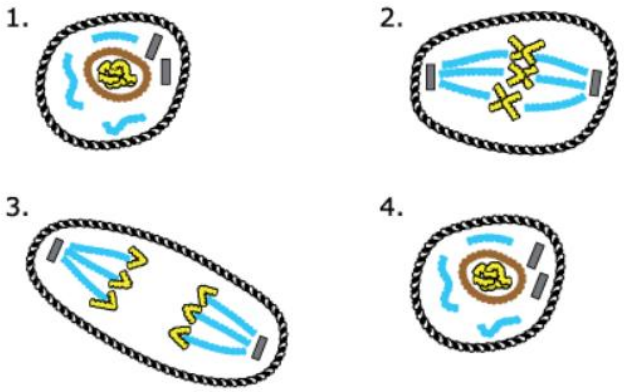
Item Information

- Answer – C
- Standard – Earth and Space Science
- Evidence Outcome – SC.HS.3.3.a
  - Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
- Disciplinary Core Idea – SC.HS.3.3
  - The rock record resulting from tectonic and other geoscience processes as well as objects from the solar system can provide evidence of Earth's early history and the relative ages of major geologic formations.
- Science and Engineering Practice – Not assessed in this item.
- Crosscutting Concept – Patterns

Item Set 2 – Question 2 (Constructed Response)

A student uses pieces of yarn to make a model of mitosis. However, the student does not accurately represent the end result of mitosis. The student's model is shown.

Student Model of Mitosis



KEY	
= spindle	= nuclear envelope
= chromosome	= centriole
= cell membrane	

Explain the function of mitosis in multicellular organisms and how the student could improve the model to more accurately represent the process. Your response should include:

- an explanation of the function of mitosis
- a description of how the student could correct the end result of mitosis in the model

Item Information

- Answer – See Scoring Rubric and Sample Student Responses
- Standard – Life Science
- Evidence Outcome – SC.HS.2.2.a
  - Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. (HS-LS1-4) (Boundary Statement: Does not include specific gene control mechanisms or rote memorization of the steps of mitosis.) |SEP 2 DUM|CCC 4 SSM|
- Disciplinary Core Idea – SC.HS.2.2
  - Growth and division of cells in complex organisms occurs by mitosis, which differentiates specific cell types.
- Science and Engineering Practice – Developing and Using Models
  - Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.
- Crosscutting Concept – Systems and System Models
- Score Point Distribution
  - 19.1% of students earned 2 points.
  - 17.2% of students earned 1 point.
  - 63.7% of students earned 0 points.

Points	Attributes
2	**The student's response should include:** • An explanation of the function of mitosis. • A description of how the student could correct the end result of mitosis in the model. **Student responses may include but are not limited to:** • The function of mitosis in multicellular organisms is to produce two genetically identical cells from one parent cell. These new cells can be used for growth or repair • The student could improve the model by showing that there are two cells at the end of mitosis, each of which is genetically identical to the parent cell.
1	Student response demonstrates a partial understanding of the task.
0	Student response does not demonstrate an understanding of the task.

Sample Student Reponses

Sample student responses are not representative of all correct answers for an item and are provided only as a guide to assist teachers with scoring.

Points – Sample Response and Annotation

2 – Sample Response and Annotation

- **Sample A Response**
  - Mitosis is used by organisms to grow. It is when one cell multiplies into two cells. The model of mitosis is incorrect because at the end there should be two cells and they should be identical.
- **Sample A Annotation**
  - The response includes an explanation of the function of mitosis (*Mitosis is used by organisms to grow. It is when one cell multiplies into two cells*). Mentioning either growth or repair is sufficient for credit for this element.
  - The response includes a description of how the student could correct the end result of mitosis in the model (*at the end there should be two cells and they should be identical*).
- **Sample B Response**
  - The model could be improved by fixing the last step. When mitosis is complete there should be two complete cells and they should both be exactly like the starting cell. This is because mitosis is the process that a person uses to make new skin, like when they have a wound.
- **Sample B Annotation**
  - The response includes an explanation of the function of mitosis (*the process that a person uses to make new skin, like when they have a wound*). A specific example of a multicellular organism growing or repairing tissue is acceptable as a response for this element.
  - The response includes a description of how the student could correct the end result of mitosis in the model (*When mitosis is complete there should be two complete cells and they should both be exactly like the starting cell*).

1 – Sample Response and Annotation

- **Sample A Response**
  - Mitosis is used by organisms to create new cells that are identical to the parent cells so it can grow new tissue. The model is correct because it shows a new cell that is identical to the parent cell.
- **Sample A Annotation**
  - The response includes an explanation of the function of mitosis (*create new cells that are identical to the parent cells so it can grow new tissue*).
  - The response incorrectly states that the model does not contain an error. While it is true that the end result of the model shows a genetically accurate cell, it should show two cells.
- **Sample B Response**
  - The function of mitosis is to split cells in half, so the model should show two cells at the end, not just one.
- **Sample B Annotation**

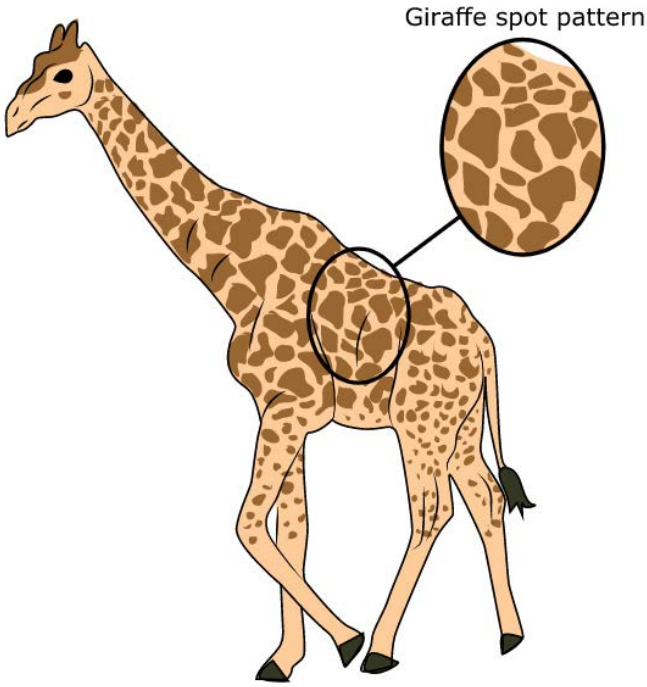
- The response includes a description of how the student could correct the end result of mitosis in the model (*the model should show two cells at the end, not just one*). The response does not indicate that the cells should be identical, but this answer is minimally sufficient to receive credit.
- The response does not explain the function of mitosis. The explanation given (*split cells in half*) does not receive credit because it is only partially correct, since the product of mitosis is two cells that are identical to the original cell, not each equal to half of the original cell. Also, the response does not indicate that the ultimate purpose of mitosis is for the organism to grow or repair itself.

0 – Sample Response and Annotation

- **Sample A Response**
  - The model is incorrect because it does not show the ribosomes.
- **Sample A Annotation**
  - The response does not address the function of mitosis.
  - The response provides an incorrect description of how the student could correct the end result of mitosis in the model. Although it is true that the model omits the ribosomes and other organelles from the diagram of the cell, including these would not improve the model, since they are not actively involved in the process of cell division.
- **Sample B Response**
  - Mitosis is when cells divide and become eggs. The model is incorrect because the final cell has too many chromosomes.
- **Sample B Annotation**
  - The response does not explain the function of mitosis or correctly identify an improvement in the model. The student has confused mitosis with meiosis.

Item Set 2 – Question 3 (Selected Response)

Giraffe spot patterns are unique to each giraffe. Scientists analyzed survival records and spot patterns of 31 mothers and their calves. Based on the evidence, the scientists made this claim: giraffe spot pattern traits are related to juvenile survival and are heritable.



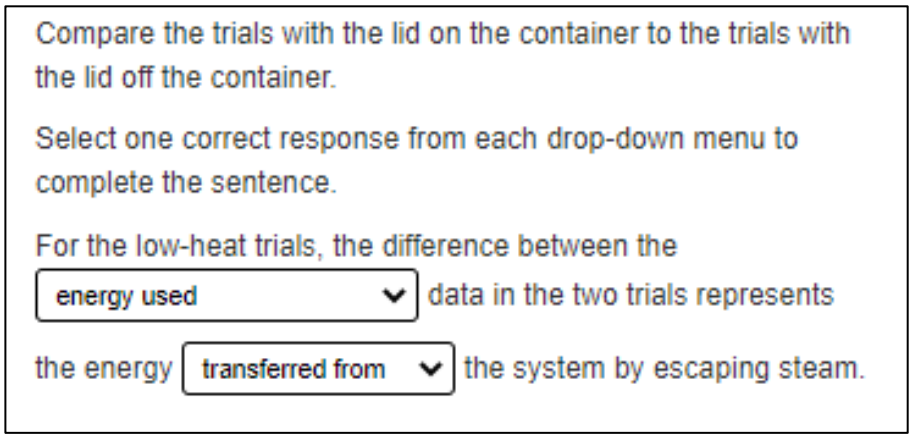
Which question is **most** closely related to the scientists' claim?

- A. How do wild giraffes' spot patterns compare with captive giraffes' spot patterns?
- B. How does the color of the spots on the calves' coats change as they grow?
- C. What role does DNA play in the spot patterns inherited by the calves?
- D. Can variation in spot patterns be used to identify individual calves?

Item Information

- Answer – C
- Standard – Life Science
- Evidence Outcome – SC.HS.2.8.a
    - Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. (HS-LS3-1) (Clarification Statement: Does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.) |SEP 1 AQDP|CCC 2 CAE|
- Disciplinary Core Idea – SC.HS.2.8
    - The characteristics of one generation are dependent upon the genetic information inherited from previous generations.
- Science and Engineering Practice – Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.
    - Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.
- Crosscutting Concept – Cause and Effect
- P Value – 0.496

Item Set 2 – Question 4 (TEI Inline Choice)



Item Information

- Answer – See Image
- Standard – Physical Science
- Evidence Outcome – SC.HS.1.7.a
    - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
- Disciplinary Core Idea – SC.HS.1.7
    - Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- Science and Engineering Practice – Not assessed in this item.
- Crosscutting Concept – Systems and System Models

Item Set 2 – Question 5 (TEI Inline Choice)

A method of energy transfer is considered to be more efficient when it uses less energy to perform the same task as other methods. The student modifies the investigation by using a lid made of a less conductive material than the metal lid used in the investigation to determine whether this will affect the efficiency of energy transfer.

Select one correct response from each drop-down menu to complete the sentence.

Using a lid made of a less conductive material than the metal lid used in the investigation will result in [less] heat lost to the surrounding environment and will [increase] the efficiency of energy transfer.

Item Information

- Answer – See Image
- Standard – Physical Science
- Evidence Outcome – SC.HS.1.9.a
    - Design, build, and refine a device that works within given constraints to convert one form of energy into another forms of energy.
- Disciplinary Core Idea – SC.HS.1.9
    - Although energy cannot be destroyed, it can be converted to less useful forms as it is captured, stored, and transferred.
- Science and Engineering Practice – Constructing Explanations and Designing Solutions
    - Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
- Crosscutting Concept – Energy and Matter

Item Set 2 – Question 6 (Constructed Response)

In the investigation in the simulation, each trial was performed with a mass of 2.8 kilograms (kg) of water. The student researched data for energy transfer and found that 261.3 Watt-hours (Wh) is the expected amount of energy required to heat 2.8 kg of water from 20°C to the boiling point.

Use the data table from the investigation to determine which of the four trials lost the **most** energy to the surrounding environment. Your response should include:

- identification of the trial that lost the most energy to the surrounding environment
- the full calculation of the approximate energy that was lost to the surrounding environment in this trial

Item Information

- Answer – See Scoring Rubric and Sample Student Responses
- Standard – Physical Science
- Evidence Outcome – SC.HS.1.7.a
    - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
- Disciplinary Core Idea – SC.HS.1.7
    - Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- Science and Engineering Practice – Using Mathematics and Computational Thinking
    - Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.
- Crosscutting Concept – Systems and System Models

Points	Attributes
2	**The student's response should include:** • Identification of the trial that lost the most energy to the surrounding environment. • A full calculation of the approximate energy that was lost to the surrounding environment in this trial. **Student responses may include but are not limited to:** • The trial that lost the most energy to the surrounding environment was the trial with low power (950 W) with the lid off. • The amount of energy lost in this trial was approximately 121 Wh, calculated by subtracting the theoretical amount of energy to heat the water from the total amount of energy used in this trial: 382.6 Wh − 261.3 Wh = 121.3 Wh.
1	Student response demonstrates a partial understanding of the task.
0	Student response does not demonstrate an understanding of the task.

Sample Student Reponses

Sample student responses are not representative of all correct answers for an item and are provided only as a guide to assist teachers with scoring.

Points – Sample Response and Annotation

2 – Sample Response and Annotation

- **Sample Response**
  - The trial that lost the most energy to the surrounding environment was the trial with low power (950 W) with the lid off.
  - The amount of energy lost in this trial was approximately 121 Wh, calculated by subtracting the theoretical amount of energy to heat the water from the total amount of energy used in this trial: 382.6 Wh − 261.3 Wh = 121.3 Wh.
- **Sample Annotation**
  - This response demonstrates a complete understanding of the task. The correct trial is identified [*the trial with low power (950 W) with the lid off*], and the approximate amount of lost energy is calculated (*subtracting the theoretical amount of energy to heat the water from the total amount of energy used in this trial: 382.6 Wh – 261.3 Wh = 121.3 Wh*).

1 – Sample Response and Annotation

- **Sample Response**
  - The trial with low heat and the lid off lost the most energy to the environment. I know this because the table shows that that combination used the most energy.
- **Sample Annotation**
  - This response demonstrates a partial understanding of the task. The correct trial is identified (*The trial with low heat and the lid off lost the most energy*), but the approximate amount of lost energy is not calculated.

0 – Sample Response and Annotation

- **Sample Response**
  - The trial with low heat and the lid on lost the most energy. I know this because the energy used, 322.9, is closest to the energy calculated, 261.3.
- **Sample Annotation**
  - This response does not demonstrate an understanding of the task. An incorrect trial is identified (*low heat and the lid on*). The approximate amount of lost energy is not calculated, numbers from the prompt are just compared.

Item Set 2 – Question 7 (Constructed Response)

Each trial in the simulation started with 2.8 liters of water at 20°C. The student modifies the investigation to mix two samples of water at different temperatures, as shown in the table.

Water Sample	Volume	Initial Temperature
A	1.4 liters	20°C
B	1.4 liters	80°C

Predict how the time required to heat the water to the boiling point in a container with the lid off at low power will be different if Sample A and Sample B are mixed to make the initial 2.8 liters of water.

Your response should include:

- a description of how to calculate the expected final temperature, in degrees Celsius (°C), when Sample A and Sample B are mixed
- an explanation of the expected time, in seconds, for the combined samples to heat to the boiling point in a container with the lid off at low power

Item Information

- Answer – See Scoring Rubric and Sample Student Responses
- Standard – Physical Science
- Evidence Outcome – SC.HS.1.7.b
    - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
- Disciplinary Core Idea – SC.HS.1.7
    - Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- Science and Engineering Practice – Not assessed in this unit.
- Crosscutting Concept – Systems and System Models

Points	Attributes
2	**The student's response should include:** • a description of how to calculate the expected final temperature, in degrees Celsius (°C), when Sample A and Sample B are mixed • an explanation of the expected time, in seconds, for the combined samples to heat to the boiling point in a container with the lid off at low power **Student responses may include but are not limited to:** • The expected result is that after the two samples of water are combined, there will be 2.8 liters of water at 50°C or an average of the two starting temperatures. • The time required to heat this sample of water to the boiling point is about 1,000 seconds. Based on the graph, it takes about 1,400 s to heat the water from 20°C to 100°C and about 400 s to heat the water from 20°C to 50°C, so starting with water at 50°C would take about 1,000 s to heat to the boiling point (1,400 s − 400 s)
1	Student response demonstrates a partial understanding of the task.
0	Student response does not demonstrate an understanding of the task.

Sample Student Reponses

Sample student responses are not representative of all correct answers for an item and are provided only as a guide to assist teachers with scoring.

Points – Sample Response and Annotation

2 – Sample Response and Annotation

- **Sample Response**
  - The expected result is that after the two samples of water are combined, there will be 2.8 liters of water at 50°C or an average of the two starting temperatures.
    The time required to heat this sample of water to the boiling point is about 1,000 seconds. Based on the graph, it takes about 1,400 s to heat the water from 20°C to 100°C and about 400 s to heat the water from 20°C to 50°C, so starting with water at 50°C would take about 1,000 s to heat to the boiling point (1,400 s − 400 s).
- **Sample Annotation**
  - This response demonstrates a complete understanding of the task. The correct final temperature of the water when samples A and B are combined is correct (*50°*) with a description (*adding 20 and 80, then dividing by 2*). The expected time is correct (*about 1,000 seconds*) and is explained (*it takes about 1,400 s to heat the water from 20°C to 100°C and about 400 s to heat … to the boiling point (1,400 s – 400 s*).

1 – Sample Response and Annotation

- **Sample Response**
  - It's going to take less time because the water is starting out warmer. At first the water was at 20°, but this time it will be at 50°. The table shows it took 1450 seconds to heat the water from 20 to 100 before. The graph shows that the water was at 50° at about 400 seconds. Subtract 1450 – 400 and the new time to boil the water is 1050 seconds.
- **Sample Annotation**
  - This response demonstrates a partial understanding of the task. The correct final temperature of the mixture of water samples A and B is given (*this time it will be at 50°*), but the response does not describe or show how that temperature was derived. The correct time involved to bring the water to a boil is given and explained (*Subtract 1450 – 400 and the new time to boil the water is 1050 seconds*).

0 – Sample Response and Annotation

- **Sample Response**
  - The time to boil the water is a lot less now than before. The water was at 20° but now it's at 80°. Before it took maybe 300 seconds to go up from 20° to 40°, so from 80° to 100° will take 300 seconds.
- **Sample Annotation**
  - This response does not demonstrate an understanding of the task. The final water temperature is incorrect (*now it's at 80°*). The time for the water to boil is incorrect due to a faulty strategy (*300 seconds*

to go up from 20° to 40°, so from 80° to 100° will take 300 seconds). Note that the graphs shown for containers without lids are not linear, so this approach is incorrect.

Item Set 2 – Question 8 (Constructed Response)

Describe the energy transfer for the investigation in the simulation, and explain a limitation for converting all the available energy into usable energy. Your response should include:

- a description of the energy transfer, including an identification of the starting form of energy and the resulting form of energy
- an explanation of a limitation for converting all the available energy into usable energy

Item Information

- Answer – See Scoring Rubric and Sample Student Responses
- Standard – Physical Science
- Evidence Outcome – SC.HS.1.9.a
  - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
- Disciplinary Core Idea – SC.HS.1.9
  - Although energy cannot be destroyed, it can be converted to less useful forms as it is captured, stored, and transferred.
- Science and Engineering Practice – Constructing Explanations and Designing Solutions
  - Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
- Crosscutting Concept – Energy and Matter

Points	Attributes
2	**The student's response should include:** • A description of the energy transfer, including an identification of the starting form of energy and the resulting form of energy. • An explanation of a limitation for converting all the available energy into usable energy. **Student responses may include but are not limited to:** • The electrical energy of the hot plate is the starting form of energy. This electrical energy is converted into thermal energy. Some of this thermal energy is absorbed by the pot-lid-water system and the rest is released into the environment. • The trial cannot be 100% efficient because some of the thermal energy produced will be released into the surrounding environment and cannot be used to heat the water.
1	Student response demonstrates a partial understanding of the task.
0	Student response does not demonstrate an understanding of the task.

Sample Student Reponses

Sample student responses are not representative of all correct answers for an item and are provided only as a guide to assist teachers with scoring.

Points – Sample Response and Annotation

2 – Sample Response and Annotation

- **Sample Response**
  - The electrical energy of the hot plate is the starting form of energy. This electrical energy is converted into thermal energy. Some of this thermal energy is absorbed by the pot-lid-water system and the rest is released into the environment.
    The trial cannot be 100% efficient because some of the thermal energy produced will be released into the surrounding environment and cannot be used to heat the water.
- **Sample Annotation**
  - This response demonstrates a complete understanding of the task. A description energy transfer including the starting form and the resulting form of the energy is provided (*electrical energy is converted into thermal energy*). An explanation of the limitation for converting all the available energy into usable energy is provided (*some of the thermal energy produced will be released into the surrounding environment and cannot be used to heat the water*).

1 – Sample Response and Annotation

- **Sample Response**
  - The energy chain starts out with electricity to power the hotplate. The hotplate uses the electricity to make heat to warm the pot and then the water in the pot. So the energy starts as electrical energy and is turned into thermal energy.
    There is a limitation for converting the energy when the switch is set to low. This limits the amount of electrical energy going to heat the water.
- **Sample Annotation**
  - This response demonstrates a partial understanding of the task. The response correctly describes the energy transfer, including the starting and resulting forms of energy (*the energy starts as electrical energy and is turned into thermal energy*). However, the response does not give a valid explanation of the limitation for converting all the available energy into usable energy because the amount of heat applied by the selection of low heat does not impact the efficient transfer of energy from one form or item to another.

0 – Sample Response and Annotation

- **Sample Response**
  - The hotplate warms the water, making it boil. The water is limited to 100°, because if it gets any hotter, it turns to steam and evaporates.
- **Sample Annotation**
  - This response does not demonstrate an understanding of the task. The description of the energy transfer is incomplete because it does not identify the starting form of electrical energy and the transfer of thermal energy is only minimally addressed. The explanation of a limitation for converting all the usable energy is incorrect because the maximum temperature of the water has no bearing on the efficient transfer of energy.

Item Set 2 – Question 9 (Selected Response)

The student wants to find out how much heat is lost to the environment in this trial from the simulation:

Power (watts)	Lid
Low: 950	On

Using the data from this trial, which calculation can be used to determine how much heat is lost to the environment?

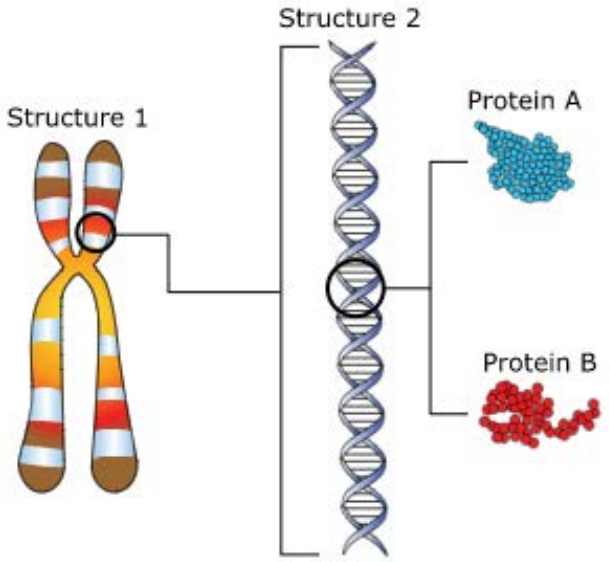
- (●) A. Subtract the energy used in this trial from the energy needed to heat the water to the boiling point.
- ( ) B. Subtract the low power of the hot plate from the maximum power capacity of the hot plate.
- ( ) C. Subtract the time for this trial from the time for the trial at the low setting with the lid off.
- ( ) D. Subtract the initial temperature from the ending temperature for this trial.

Item Information

- Answer – A
- Standard – Physical Science
- Evidence Outcome – SC.HS.1.7.a
    - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
- Disciplinary Core Idea – SC.HS.1.7
    - Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- Science and Engineering Practice – Using Mathematics and Computational Thinking
    - Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.
- Crosscutting Concept – Systems and System Models

Item Set 2 – Question 10 (Constructed Response)

A student investigates why so many parental characteristics are expressed in their offspring. The student makes a model to represent the structures involved in the passing of traits from parent to offspring.



Identify the structures using the student's model and explain how proteins that result in different traits can be formed from the same structure. Your answer should include:

- the identification of Structure 1 and Structure 2
- an explanation of how different traits arise from proteins formed from these structures

Item Information

- Answer – See Scoring Rubric and Sample Student Responses
- Standard – Life Science
- Evidence Outcome – SC.HS.2.8.a
    - Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
- Disciplinary Core Idea – SC.HS.2.8
    - The characteristics of one generation are dependent upon the genetic information inherited from previous generations.
- Science and Engineering Practice – Not assessed in this item.
- Crosscutting Concept – Cause and Effect

Points	Attributes
2	**The student's response should include:** • The identification of Structure 1 and Structure 2. • An explanation of how different traits arise in offspring from proteins formed from these structures. **Student responses may include but are not limited to:** • Structure 1 is a chromosome, and Structure 2 is the DNA found on the chromosome. • Protein A and Protein B are each formed from instructions carried on different genes in the DNA that is inherited from the parents. Each protein has distinct properties and either play different roles or determine different traits in an individual.
1	Student response demonstrates a partial understanding of the task.
0	Student response does not demonstrate an understanding of the task.

Sample Student Reponses

Sample student responses are not representative of all correct answers for an item and are provided only as a guide to assist teachers with scoring.

Points – Sample Response and Annotation

2 – Sample Response and Annotation

- **Sample Response**
  - Structure 1 is a chromosome, and Structure 2 is the DNA found on the chromosome.
  - Protein A and Protein B are each formed from instructions carried on different genes in the DNA that is inherited from the parents. Each protein has distinct properties and either play different roles or determine different traits in an individual.
- **Sample Annotation**
  - The response demonstrates a complete understanding of the task. The two structures shown in the diagram are identified *(Structure 1 is a chromosome, and Structure 2 is the DNA found on the chromosome)* and a complete explanation of how different traits arise from proteins formed by these structures is provided *(Protein A and Protein B are each formed from instructions carried on different genes in the DNA that is inherited from the parents. Each protein has distinct properties*).

1 – Sample Response and Annotation

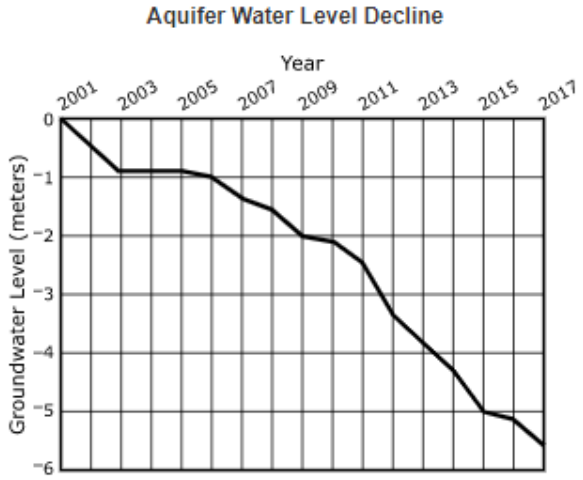
- **Sample Response**
  - Parents pass their traits to their children on their DNA. The DNA says what protein it will make.
- **Sample Annotation**
  - This response demonstrates a partial understanding of the task. An explanation of the relationship between DNA and proteins and how traits are passed from parent to offspring (*Parent pass their traits … on their DNA. The DNA says what protein it will make*) is provided. Neither structure is identified.

0 – Sample Response and Annotation

- **Sample Response**
  - DNA can make your eyes blue or it can make your eyes brown.
- **Sample Annotation**
  - This response does not demonstrate an understanding of the task. The explanation provided is too vague to demonstrate any understanding of the task.

Item Set 2 – Question 11 (Multiple Select)

An agricultural community uses an aquifer, described in Part 1, as a water source for farming and for residential use. The community monitors the water level of the aquifer. The graph shows the changes in the water level from January 2001 through January 2017.



Which actions would most effectively conserve the aquifer water level? Select **two** correct statements.

- [x] A. The local government enacts water conservation policies for residents.
- [ ] B. Farmers replace the layer of topsoil to make it more permeable.
- [ ] C. The community adds porous rock above the aquifer.
- [x] D. Farmers grow crops that require less irrigation.
- [ ] E. The community relocates to another area.

Item Information

- Answer – A, D
- Standard – Earth and Space Science
- Evidence Outcome – SC.HS.3.9.a
  - Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- Disciplinary Core Idea – SC.HS.3.9
  - Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
- Science and Engineering Practice – Constructing Explanations and Designing Solutions
  - Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
- Crosscutting Concept – Cause and Effect

Item Set 2 – Question 12 (Selected Response)

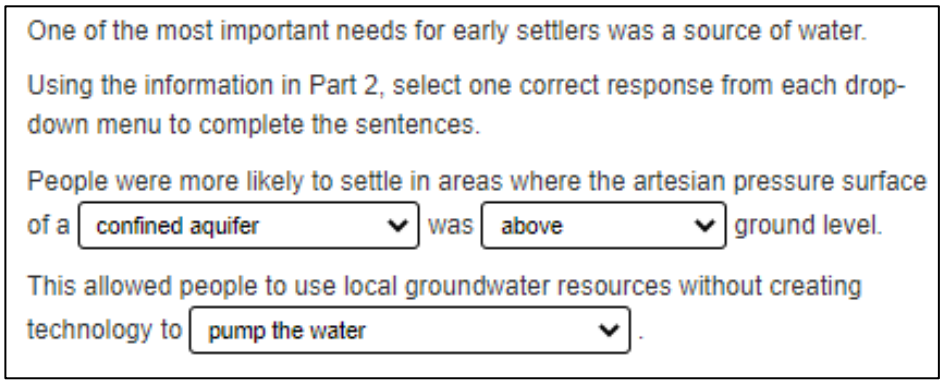
Based on Figure 1, which statement most correctly explains why people need to drill below the water table in an aquifer?

- A. Water below the water table in aquifers increases the water supply when there is not enough water from nearby lakes and springs.
- B. Water below the water table in aquifers flows through an aquifer more rapidly than surface water flows into a lake.
- C. Water below the water table in aquifers is more easily accessible than water from nearby lakes and springs.
- D. Water below the water table in aquifers is under less pressure than water from nearby lakes and springs.

Item Information

- Answer – A
- Standard – Earth and Space Science
- Evidence Outcome – SC.HS.3.9.a
    - Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- Disciplinary Core Idea – SC.HS.3.9
    - Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
- Science and Engineering Practice – Constructing Explanations and Designing Solutions
    - Construct an explanation using models or representations.
- Crosscutting Concept – Cause and Effect

Item Set 2 – Question 13 (TEI Inline Choice)

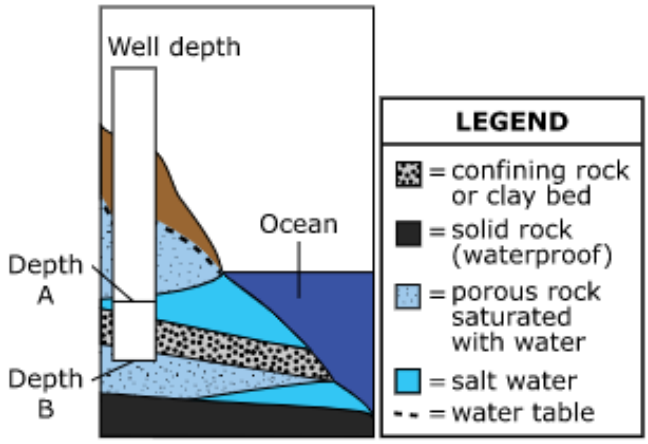


Item Information

- Answer – See Image
- Standard – Earth and Space Science
- Evidence Outcome – SC.HS.3.9.a
    - Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- Disciplinary Core Idea – SC.HS.3.9
    - Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
- Science and Engineering Practice – Constructing Explanations and Designing Solutions
    - Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real world phenomena, examples, or events.
- Crosscutting Concept – Cause and Effect

Item Set 2 – Question 14 (Constructed Response)

The diagram shows a proposed drill site for a well.



Use the information in Part 2 to evaluate the costs and benefits of a well with Depth A and a well with Depth B. Your response should include:

- a cost comparison between the wells at Depth A and Depth B
- a performance comparison between the wells at Depth A and Depth B

Item Information

- Answer – See Scoring Rubric and Sample Student Responses
- Standard – Earth and Space Science
- Evidence Outcome – SC.HS.3.9.b
  - Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
- Disciplinary Core Idea – SC.HS.3.9
  - Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
- Science and Engineering Practice – Engaging in Argument from Evidence
  - Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., tradeoffs), constraints, and ethical issues.
- Crosscutting Concept – CCC Not Assessed

Points	Attributes
2	**The student's response should include:** • A cost comparison between the wells at Depth A and Depth B. • A performance comparison between the wells at Depth A and Depth B. **Student responses may include but are not limited to:** • It will cost more to drill to Depth B than Depth A. • A well at Depth B will need less pumping than one at Depth A, and there would be less salt water mixed in with the fresh water at Depth B.
1	Student response demonstrates a partial understanding of the task.
0	Student response does not demonstrate an understanding of the task.

Sample Student Reponses

Sample student responses are not representative of all correct answers for an item and are provided only as a guide to assist teachers with scoring.

Points – Sample Response and Annotation

2 – Sample Response and Annotation

- **Sample Response**
  - It will cost more to drill to Depth B than Depth A.
    A well at Depth B will need less pumping than one at Depth A, and there would be less salt water mixed in with the fresh water at Depth B.
- **Sample Annotation**
  - The student demonstrates a complete understanding of the task. A correct cost comparison is made between the wells at depth A and depth B *(It will cost more to drill to Depth B).* A correct performance comparison is provided *(A well at Depth B will need less pumping … there would be less salt water mixed in with the fresh water),* addressing both the salinity of the water and the necessity of a pump for both depths.

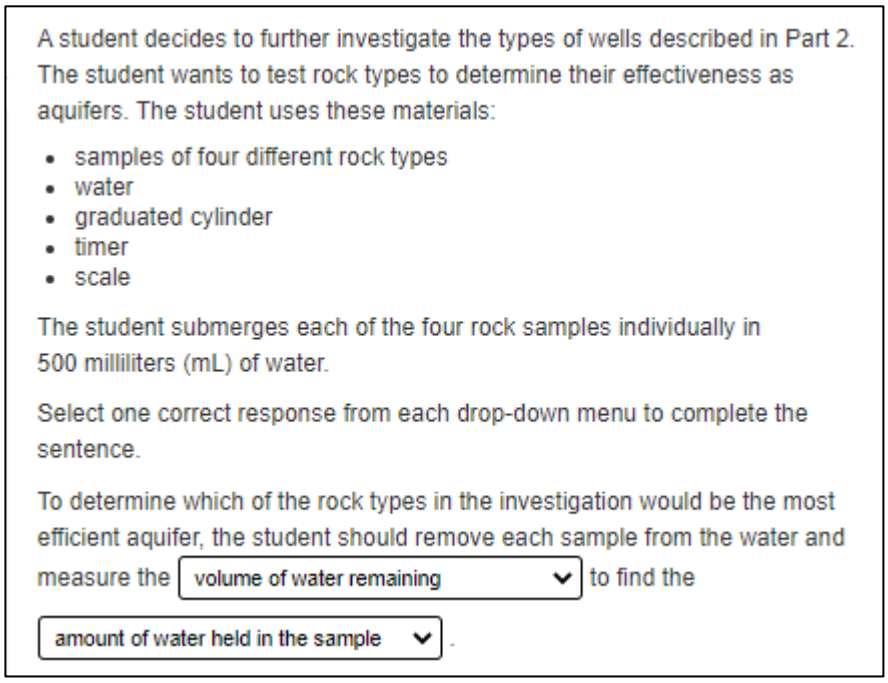
1 – Sample Response and Annotation

- **Sample Response**
  - The well at depth B would be more expensive than depth A. Since B is deeper, it will be harder to pump the water out.
- **Sample Annotation**
  - This response demonstrates a partial understanding of the task. The cost comparison on the two depths is correct (*depth B would be more expensive than depth A*). The performance comparison is incorrect (*B … will be harder to pump the water out*) and incomplete because it lacks a comparison of the salinity of the water at each depth.

0 – Sample Response and Annotation

- **Sample Response**
  - Drilling a well to depth A will probably cost more to drill than depth B. The wells both have water, but the water from B is probably better, since it comes from farther down.
- **Sample Annotation**
  - This response does not demonstrate an understanding of the task. The comparison of costs for the two depths is incorrect *(depth A will probably cost more).* The performance comparison is incomplete because there is no mention of the relative salinity or necessity of a pump for the two depths**.**

Item Set 2 – Question 15 (TEI Inline Choice)



Item Information

- Answer – See Image
- Standard – Earth and Space Science
- Evidence Outcome – SC.HS.3.9.a
    - Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- Disciplinary Core Idea – SC.HS.3.6
    - The planet's dynamics are greatly influenced by water's unique chemical and physical properties.
- Science and Engineering Practice – Planning and Carrying Out Investigations
    - Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigations design to ensure variables are controlled.
- Crosscutting Concept – Structure and Function