

Colorado CMAS High School Science Practice

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Colorado Measures of Academic Success



High School Science



Paper Practice Resource for Students

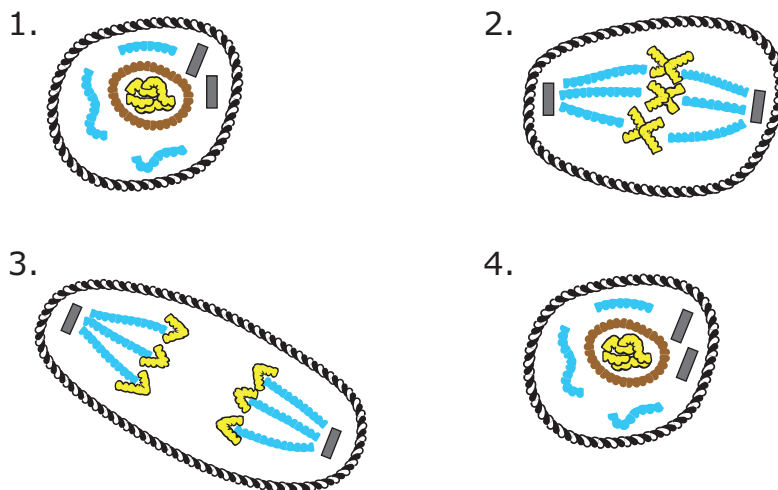
1. Giant pandas and red pandas both eat bamboo and have a modified wrist bone that functions like a thumb to help the animals grip bamboo while eating. A student claims that giant pandas and red pandas must be related because of these similarities.

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

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

2. 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

This image shows a single sheet of white paper with horizontal blue ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Directions: Use the information to answer questions 3 through 7.

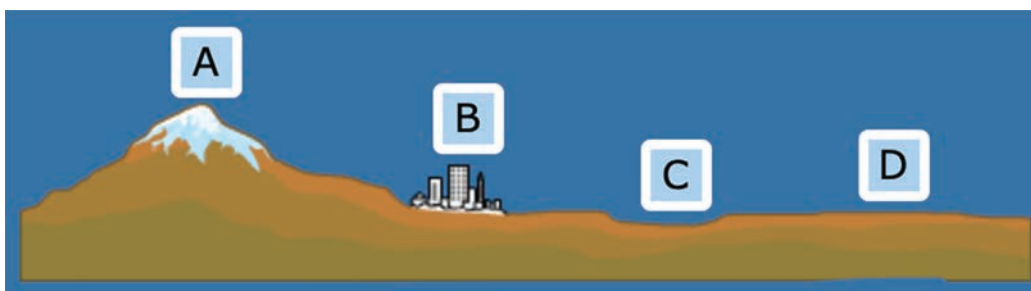
The energy output of wind turbines is influenced by three main factors: wind speed, air density, and rotor diameter. Selecting a location for wind turbines requires consideration of possible environmental impacts and effects on the community.

Part 1

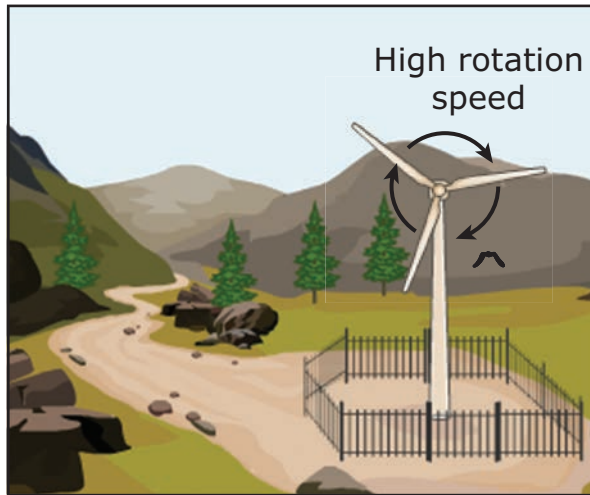
Part 1 shows four locations to consider for wind turbine placement and the impact, cost, and energy output for each location.

View the characteristics of the location and the movement of the wind turbine at locations A, B, C, and D. Then observe the results in the data table.

Locations A, B, C, and D

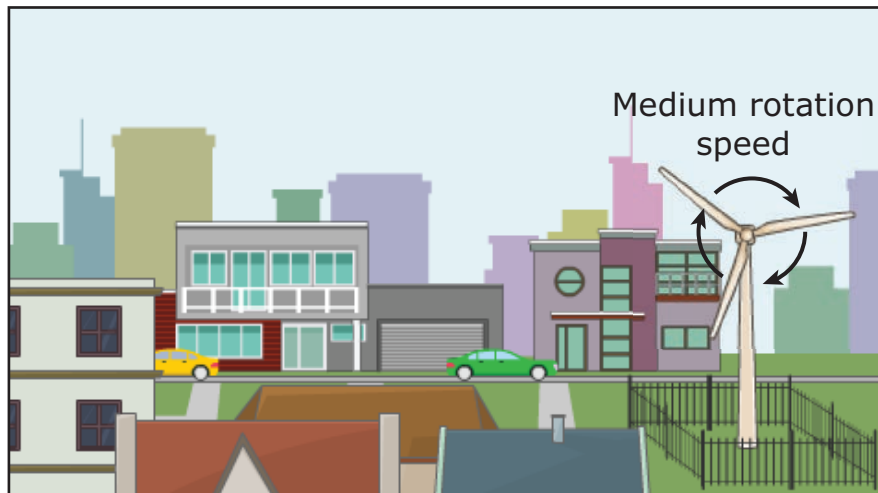


Location A

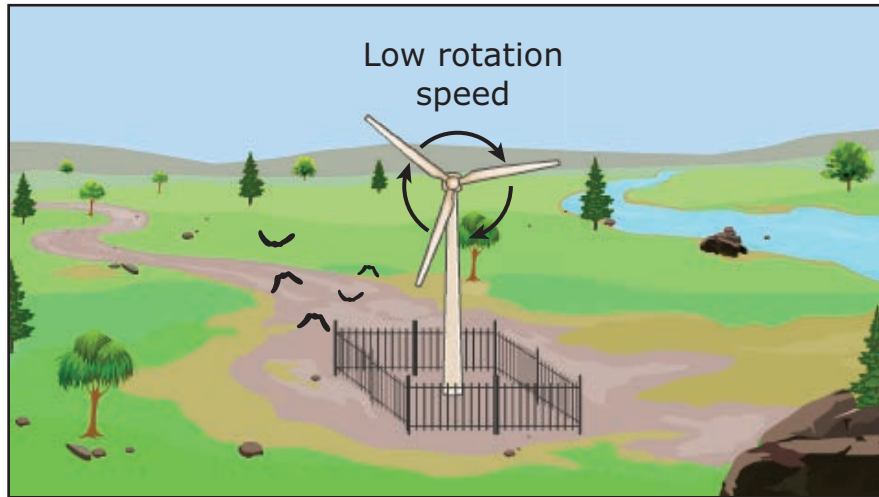


Wind speed sensors record maximum speed reached, shutting turbine down for safety.

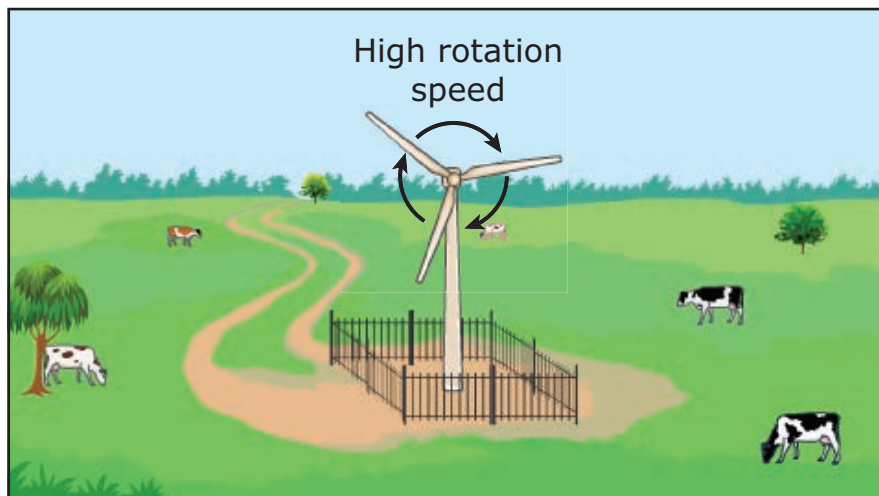
Location B



Location C



Location D



The table shows various impacts of building in each of the locations.

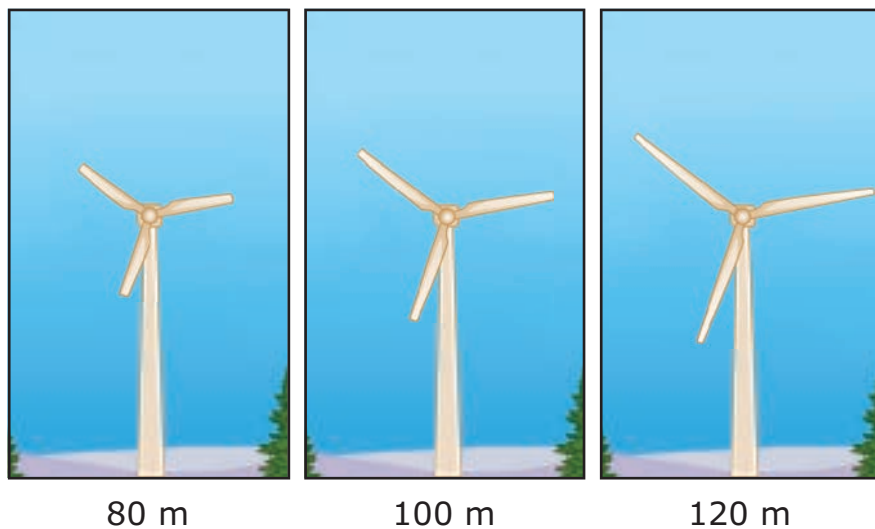
Part 1 Data Table

Location	Impact to Humans	Impact to Ecosystem	Monetary Cost	Energy Output
A	low	medium	high	high
B	high	low	medium	medium
C	low	high	medium	low
D	low	low	low	high

Part 2

Part 2 shows wind turbines with different rotor diameters, in meters (m). The rotor diameter of the wind turbine affects the amount of energy produced, in megawatt-hours (MWh).

Rotor Diameter



The data table shows the average amount of energy produced for each rotor size operating under identical conditions.

Energy Production Based on Rotor Diameter

Rotor Diameter (m)	Electricity Produced (MWh)
80	1,500
100	2,300
120	3,300

3. 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.

Place a check mark (✓) to select an answer in each row. 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.		

4. 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

5. The community builds multiple wind turbines at Location A. Why has the community **most likely** chosen Location A to install wind turbines?
- Ⓐ The location is the most accessible for building large structures.
 - Ⓑ The location is the closest to a major metropolitan area.
 - Ⓒ The location has a high availability of wind resources.
 - Ⓓ The location has the lowest environmental impact.

- 6.** 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?

Circle one correct response from each box to complete the sentences.

Using larger rotors means _____ turbines are needed, on average,

fewer
more

to meet electricity production goals. This ultimately leads to _____

higher
lower

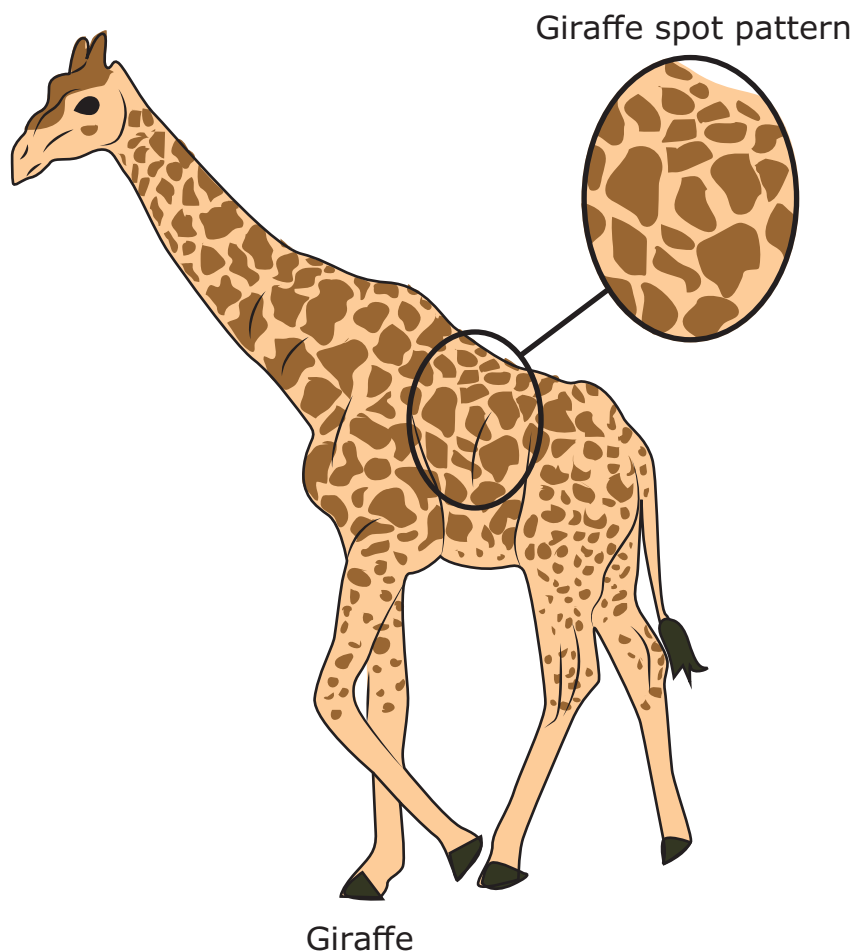
long-term costs. Because different locations vary in average wind speed, peak wind speed, and a variety of other conditions, the trend toward larger rotors will _____.

accelerate over time
not be universal
soon end

7. 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

8. 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.

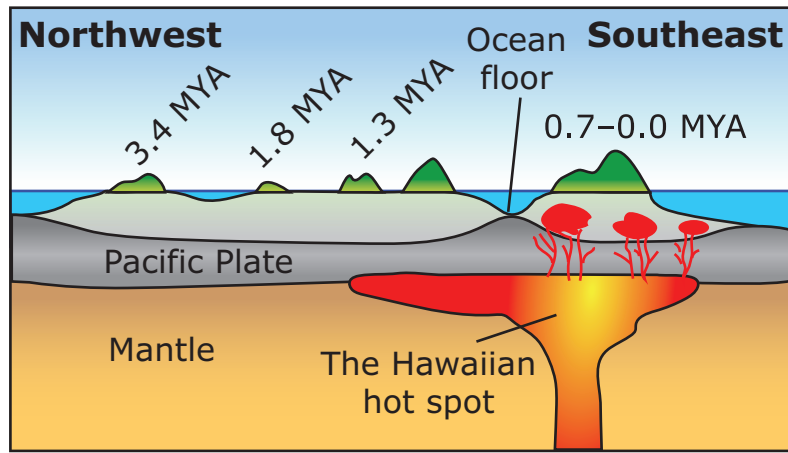


Which question is **most** closely related to the scientists' claim?

- (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?

This is the end of Item Set 1.

1. 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.

2. 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	186

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.

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

Directions: Use the information to answer questions 3 through 7.

Part 1

People sometimes feel tired after eating. Students research the ways the body responds during the digestion process. A reliable website describes several steps in this process in order:

1. Hormones are released.
2. These hormones dilate blood vessels that lead to the digestive system.
3. Blood pressure starts to drop as more blood flows to the digestive system.
4. The heart pumps faster, and blood vessels in other parts of the body constrict.

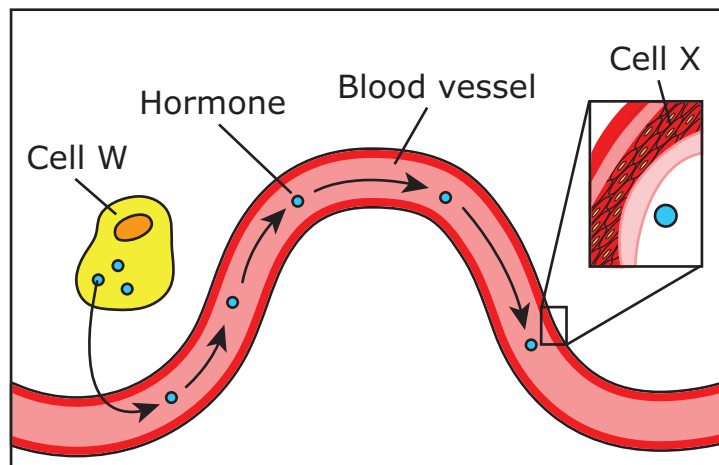
Part 2

The students decided to investigate the responses of body systems to eating a meal. They selected five subjects to participate in their investigation.

For each subject, the students collected several kinds of data:

- mass of subject
- size of meal
- heart rate and blood pressure before meal
- heart rate and blood pressure after meal
- whether subject is male or female
- age of subject

3. Study the model of hormone interactions.



Circle one correct response in each box 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 _____ system. The hormone leaves the

circulatory
endocrine
muscular

circulatory system and binds to Cell X in _____

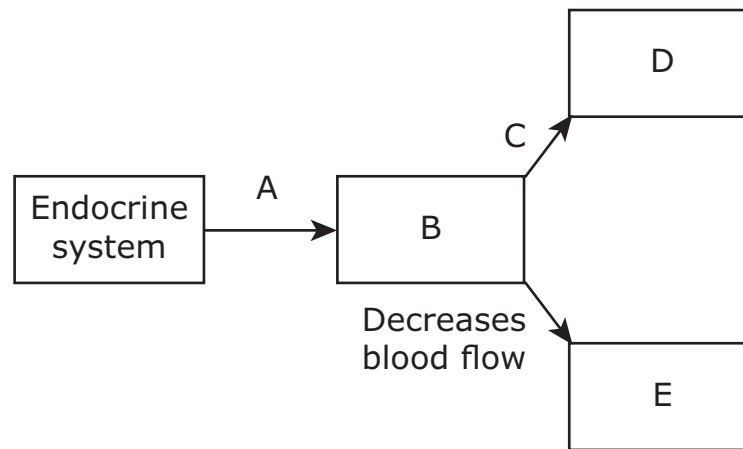
the endocrine system
muscle tissue

that _____.

changes shape to dilate vessels
captures hormones for later use

4. This model shows some interactions of the endocrine system with other body systems.

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.

Write the correct letter from the model in the table to label the step or body system. Each letter may be used once.

Letter	Step or Body System
_____	Step 1
_____	Step 3
_____	nervous system
_____	digestive system
_____	circulatory system

5. 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.

6. The students want to compare the data measured for each subject in the digestion investigation described in Part 2.

Circle one correct response in each box to complete the sentences.

The students can better compare data if the ratio of
the _____ to the _____

energy content of the meal
age of the subject

mass of the subject
sex of the subject

is consistent for all the participants. This will help ensure that the
data collected provides accurate evidence about how a subject's
body systems work _____ to _____ homeostasis.

independently
together

disrupt
maintain

7. 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

Directions: Use the information to answer questions 8 through 13.

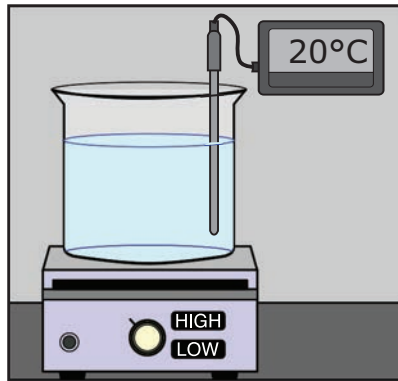
A student boils water for pasta and notices that the water boils faster when there is a lid on the pot. The student wonders whether energy can be saved by boiling water with the lid on. The student conducts an experiment to investigate the energy used to boil water at sea level under several different conditions. The experiment uses a hot plate with settings given in watts (W). The student compares the time it takes for the water to boil, in seconds (s), to the amount of electrical energy used, in watt-hours (Wh), for these four trials:

- Trial 1: low power (950 W) with lid off
- Trial 2: low power (950 W) with lid on
- Trial 3: high power (1,500 W) with lid off
- Trial 4: high power (1,500 W) with lid on

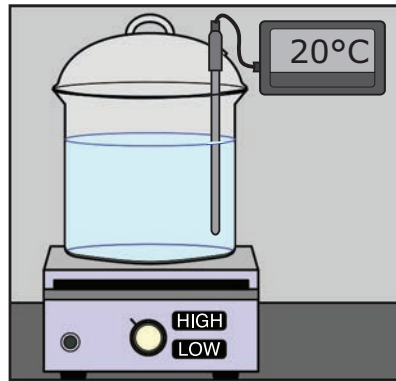
The student follows these steps:

1. Heat the water at the low power setting in the pot with the lid off until it boils.
2. Record the time it takes for the water temperature to reach the boiling point. Temperature is measured in degrees Celsius ($^{\circ}\text{C}$).
3. Calculate the total energy used.
4. Repeat steps 1–3 for each condition.

Starting Setup for All Trials

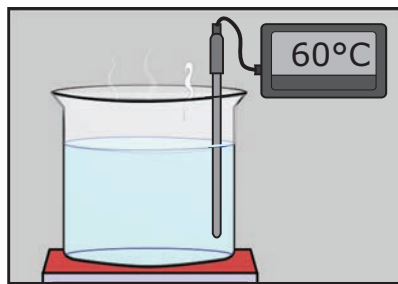


Lid off

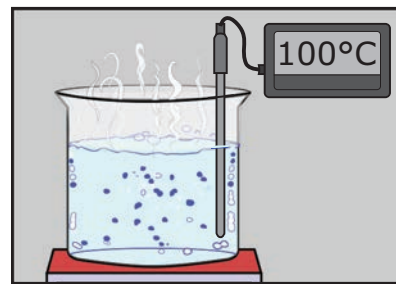


Lid on

Observations for Trial 1: Low Power (950 watts) with Lid Off

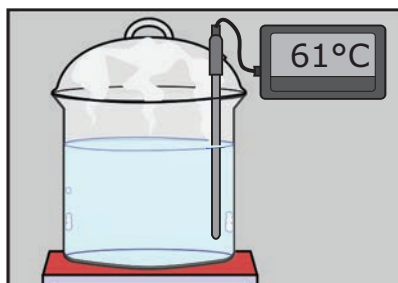


600 seconds

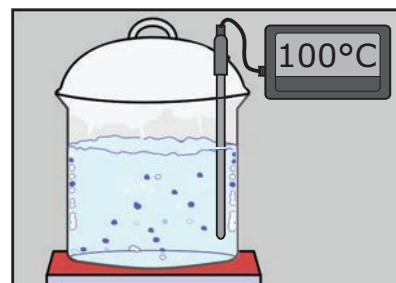


1,450 seconds

Observations for Trial 2: Low Power (950 watts) with Lid On



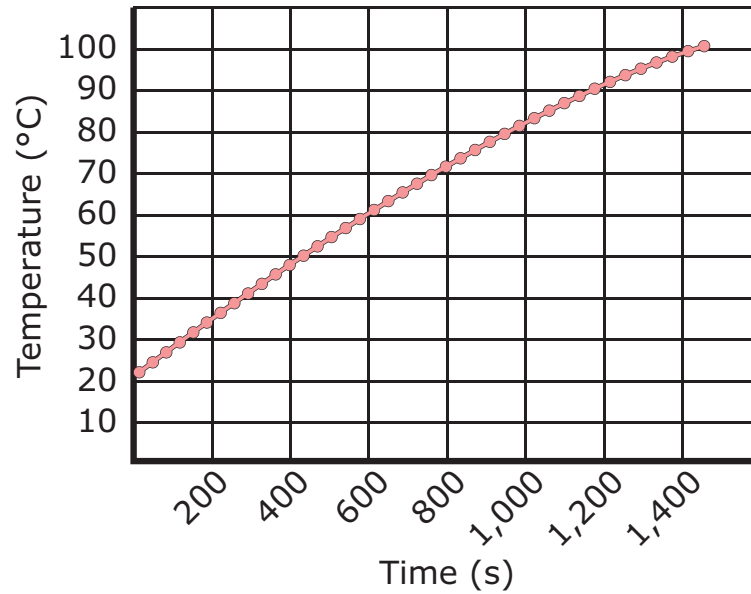
600 seconds



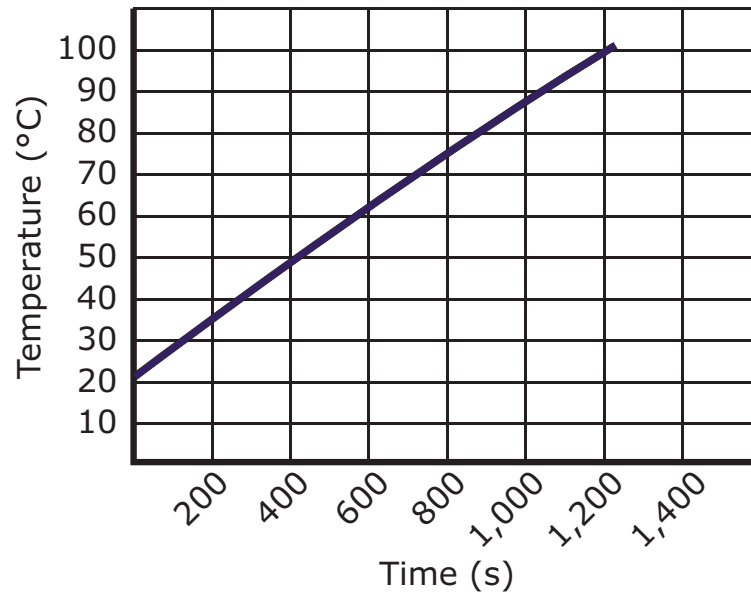
1,215 seconds

Temperature Graphs for Trial 1 and Trial 2

Trial 1: Low Power, Lid Off

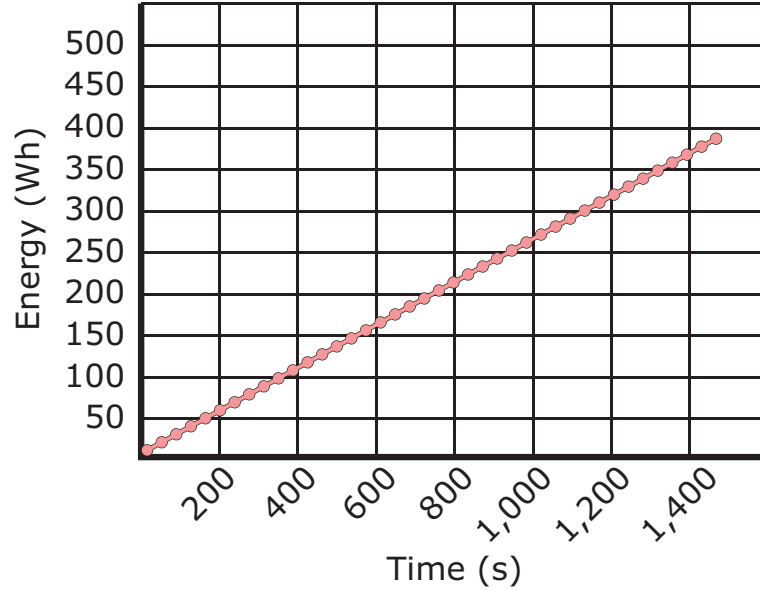


Trial 2: Low Power, Lid On

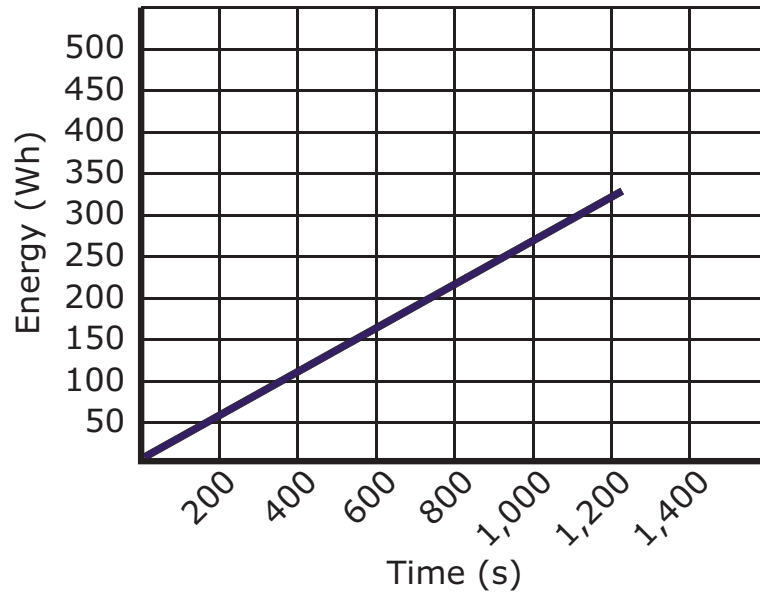


Energy Graphs for Trial 1 and Trial 2

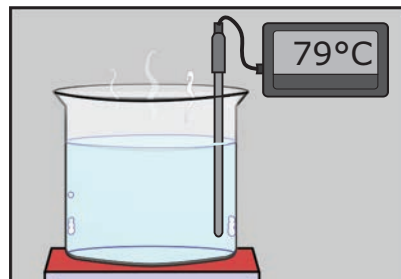
Trial 1: Low Power, Lid Off



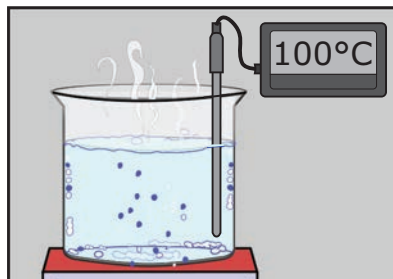
Trial 2: Low Power, Lid On



Observations for Trial 3: High Power (1,500 watts) with Lid Off

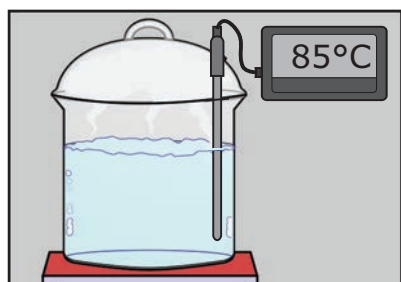


600 seconds

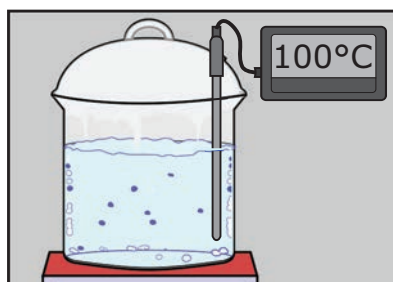


820 seconds

Observations for Trial 4: High Power (1,500 watts) with Lid On



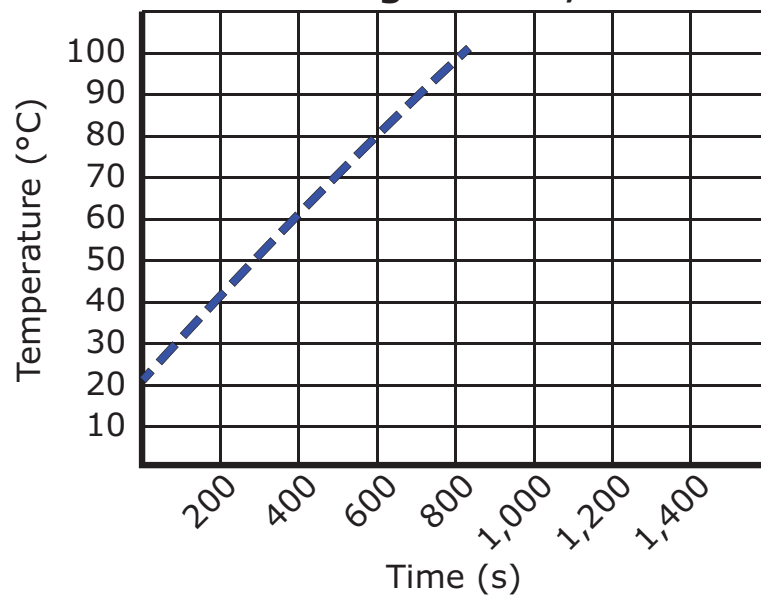
600 seconds



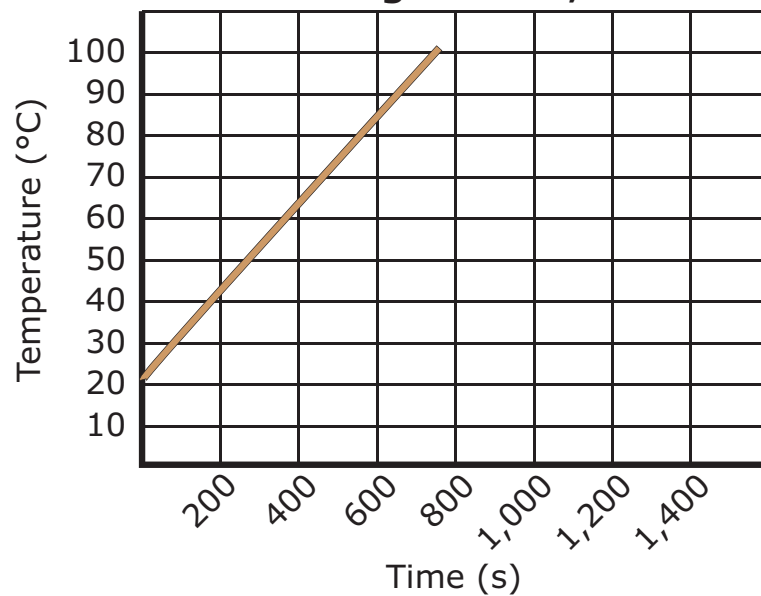
775 seconds

Temperature Graphs for Trial 3 and Trial 4

Trial 3: High Power, Lid Off

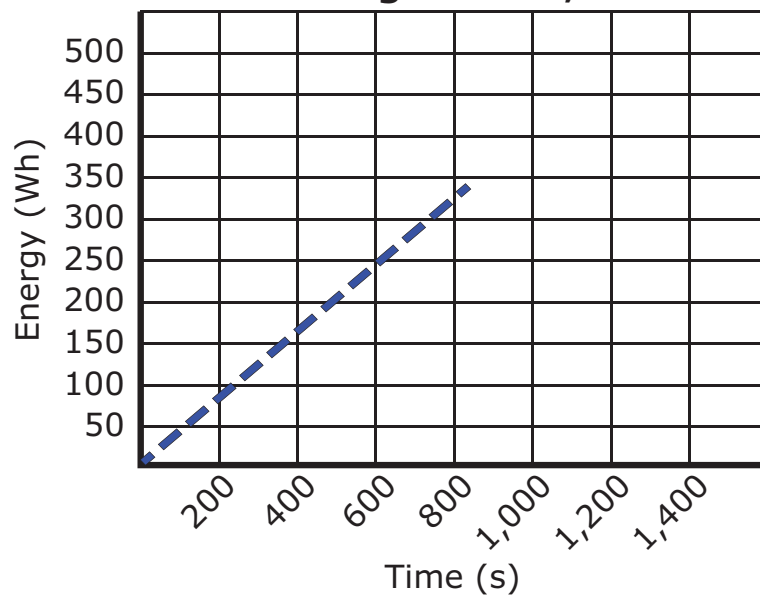


Trial 4: High Power, Lid On

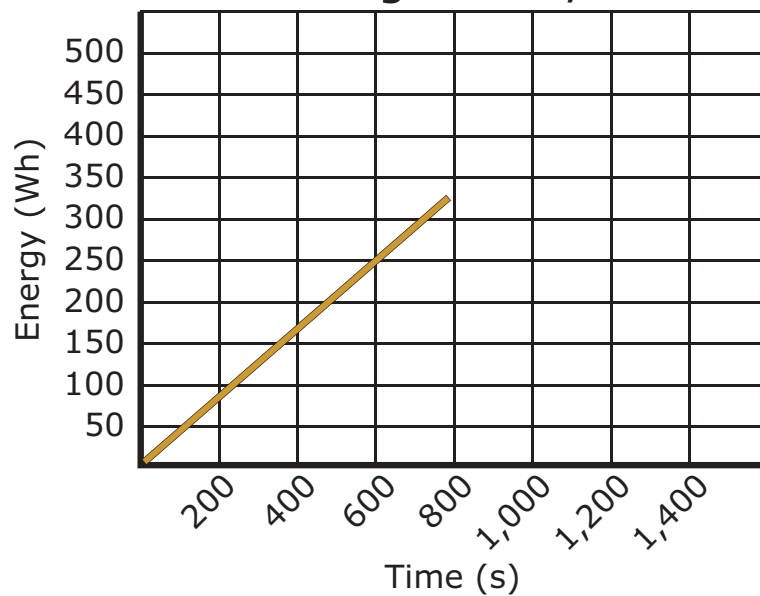


Energy Graphs for Trial 3 and Trial 4

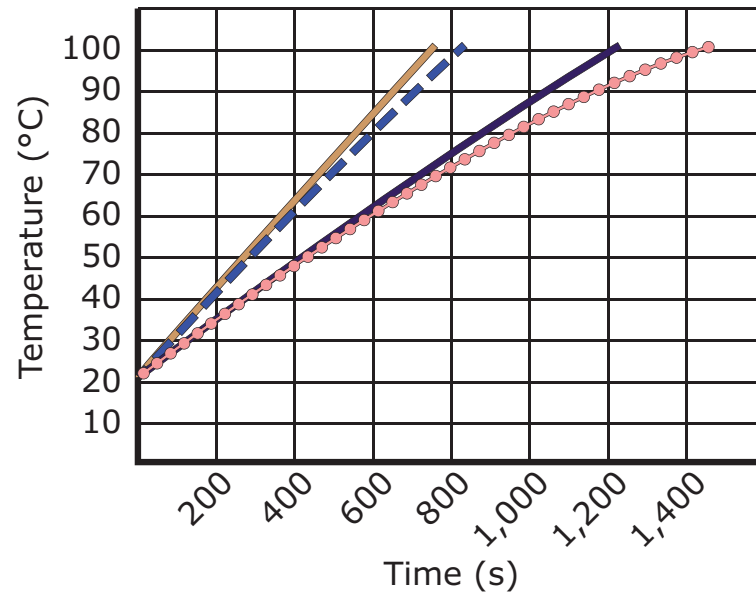
Trial 3: High Power, Lid Off



Trial 4: High Power, Lid On

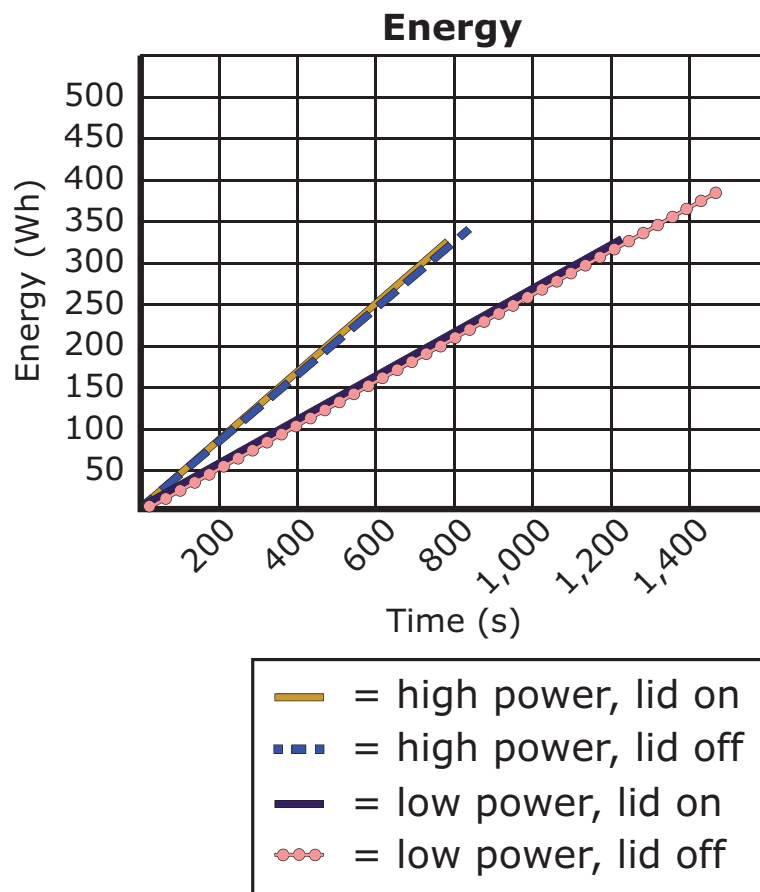


Combined Temperature Graphs



- = high power, lid on
- - - = high power, lid off
- = low power, lid on
- · · = low power, lid off

Combined Energy Graphs



Data for All Trials

Hot Plate Setting	Time to Reach Boiling (s)		Energy Used (Wh)	
	Lid On	Lid Off	Lid On	Lid Off
low (950 W)	1,215	1,450	320.6	382.6
high (1,500 W)	775	820	322.9	341.7

8. Compare the trials with the lid on the container to the trials with the lid off the container.

Circle one correct response in each box to complete the sentence.

For the low-heat trials, the difference between the

time to reach boiling
energy used

data in the two trials represents the energy _____ the

transferred from
added to

system by escaping steam.

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

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?

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

- 10.** 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.

Circle one correct phrase in each box to complete the sentence.

Using a lid made of a less conductive material than the metal lid used in the investigation will result in _____ heat lost to

less
more
the same amount of

the surrounding environment and will _____ the efficiency of

increase
decrease
not affect

energy transfer.

11. Describe the energy transfer for the investigation shown, 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

- 12.** In the investigation, 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

- 13.** Each trial in the investigation 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

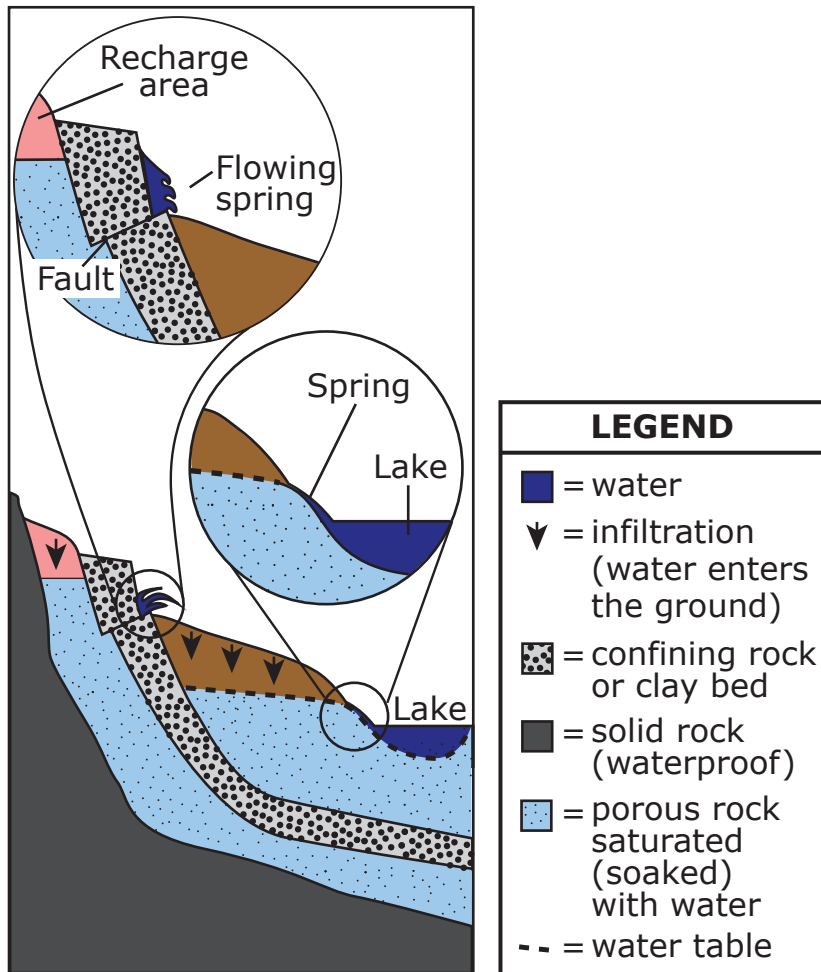
Directions: Use the information to answer questions 14 through 18.

Part 1

A television program shows a spring, a trickle of water flowing directly out of the side of a hill to become a small stream. A student decides to research different ways groundwater can reach the surface. Springs can come from groundwater in the saturated zone below the surface. They can also come from groundwater that lies beneath a rock layer through which water cannot normally pass. Water beneath such a rock layer is at higher pressure than water above the layer.

Both sources of groundwater are called aquifers. Precipitation or snowmelt can add water to an aquifer by infiltrating the soil and ground above it. The area where this happens is called a recharge area. Aquifers under confining rock layers often have much smaller recharge areas than unconfined aquifers.

Figure 1: Groundwater and Springs



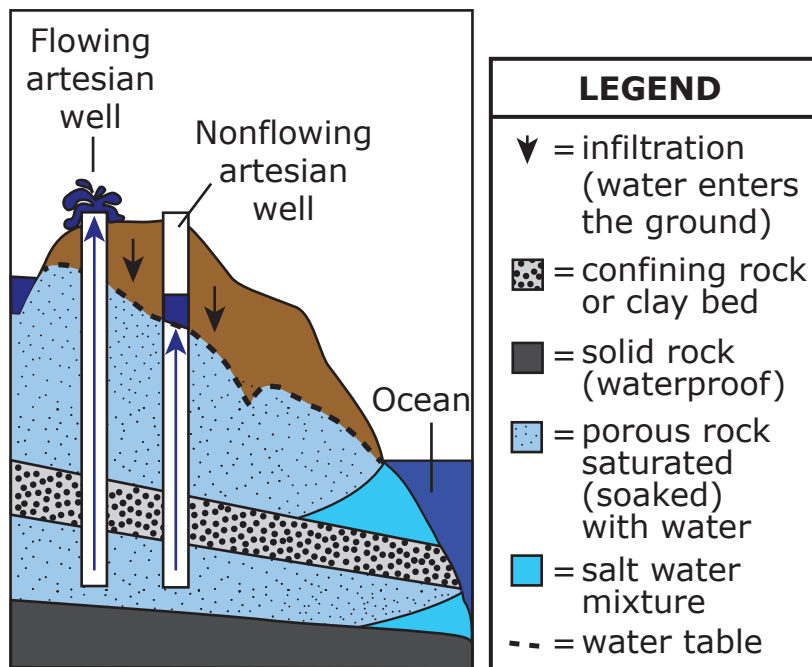
Part 2

In some places, people drill wells to access groundwater.

An artesian well is created when people drill deep enough to reach a confined aquifer. A confined aquifer is an aquifer with water that cannot reach the surface because it is below a layer of rock.

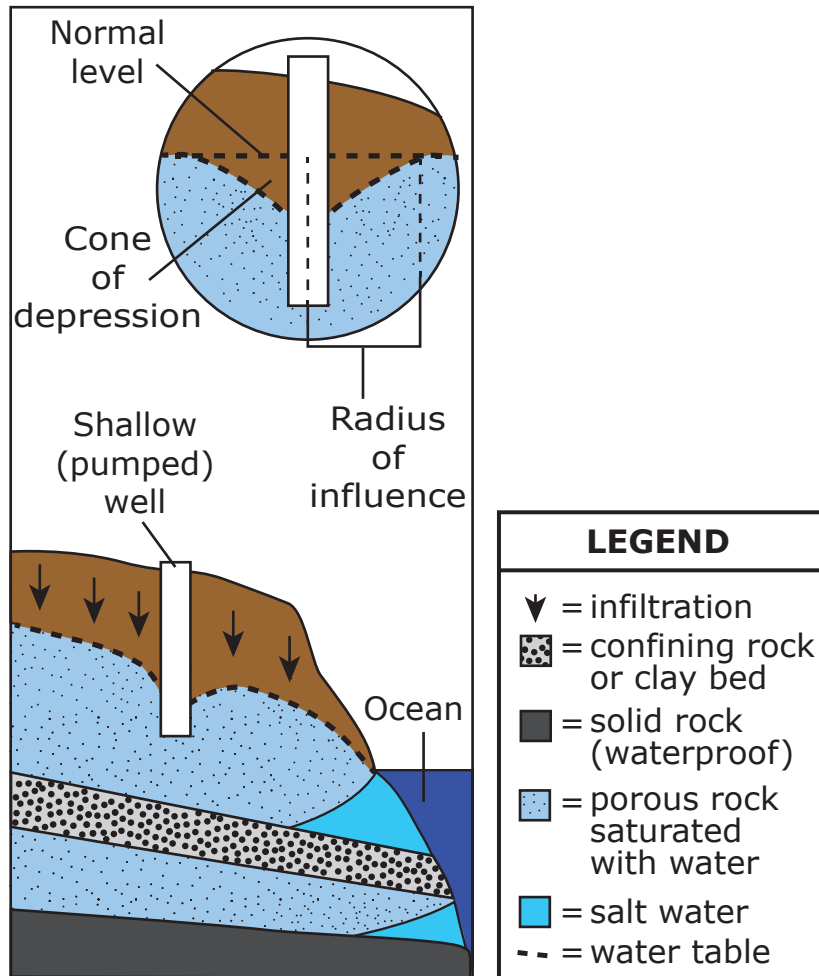
If the rock layer is breached, water pressure from a confined aquifer pushes water above the water table. This is the artesian pressure surface. When this surface is higher than ground level, water flows from the artesian well without being pumped.

Figure 2: Artesian Wells



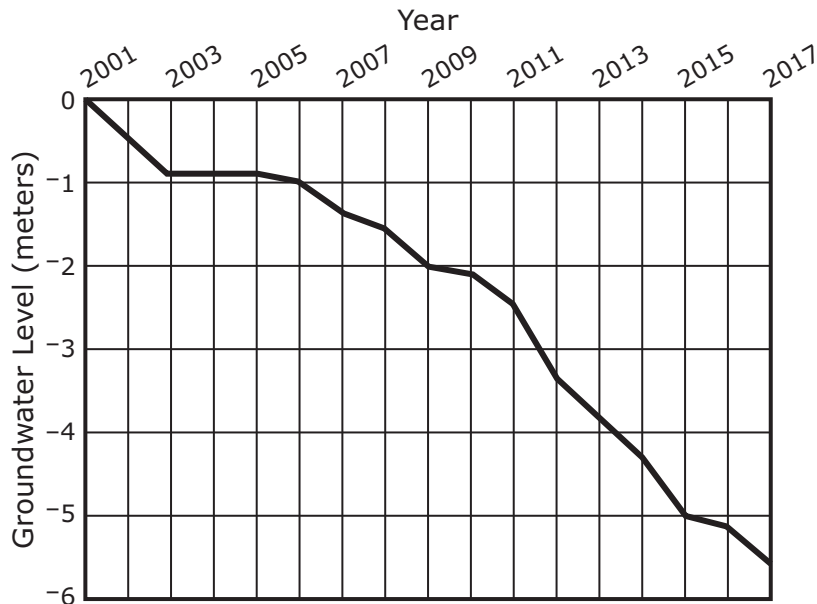
Wells that are more shallow use a pump to pull water from below the water table. While the pump operates, the water table around the well is lowered in a cone shape, named the cone of depression. The cone grows larger when the rate of pumping is greater.

Figure 3: Pumped Well



- 14.** 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.

Aquifer Water Level Decline



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

- ☐ 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.
- ☐ D Farmers grow crops that require less irrigation.
- ☐ E The community relocates to another area.

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

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

16. A student decides to further investigate the types of wells described in Part 2. The student wants to test rock types to determine their effectiveness as aquifers. The student uses these materials:

- samples of four different rock types
- water
- graduated cylinder
- timer
- scale

The student submerges each of the four rock samples individually in 500 milliliters (mL) of water.

Circle one correct response in each box to complete the sentence.

To determine which of the rock types in the investigation would be the most efficient aquifer, the student should remove each sample from the water and measure the

time the sample was submerged
volume of water remaining

to find the _____ .

amount of water held in the sample
total mass of the sample and water
flow rate of the water

- 17.** One of the most important needs for early settlers was a source of water.

Using the information in Part 2, circle one correct response in each box to complete the sentences.

People were more likely to settle in areas where the artesian pressure surface of a _____ was _____

cone of depression
confined aquifer
recharge area

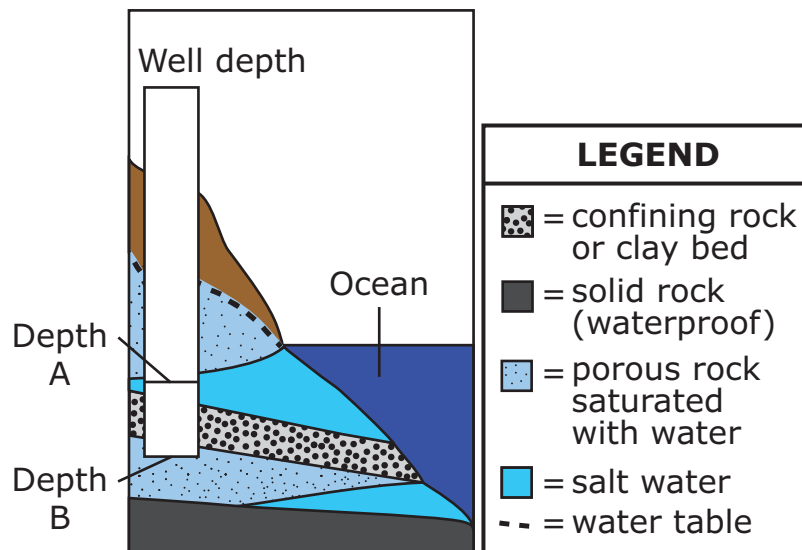
far below
above

ground level.

This allowed people to use local groundwater resources without creating technology to _____.

move the water above the water table
drill through a rock layer
pump the water

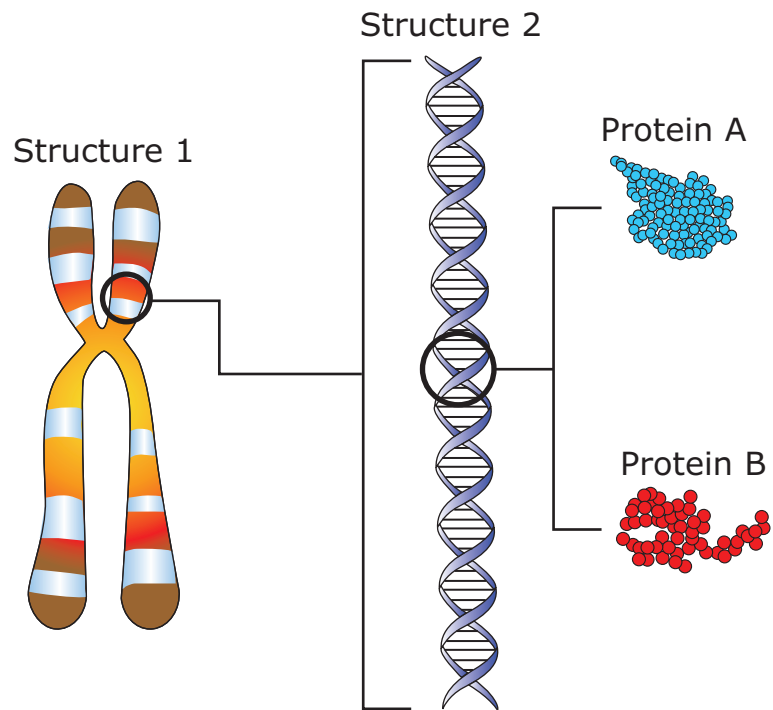
18. The diagram shows a proposed drill site for a well.



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

- 19.** 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

This is the end of Item Set 2.



Colorado Measures of Academic Success



High School Science

Answer Key with Scoring Rubrics, Sample Responses & Annotations

Practice Resource for Students

ANSWER KEY: ITEM SET 1

Item Set 1 – Question 1 (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?

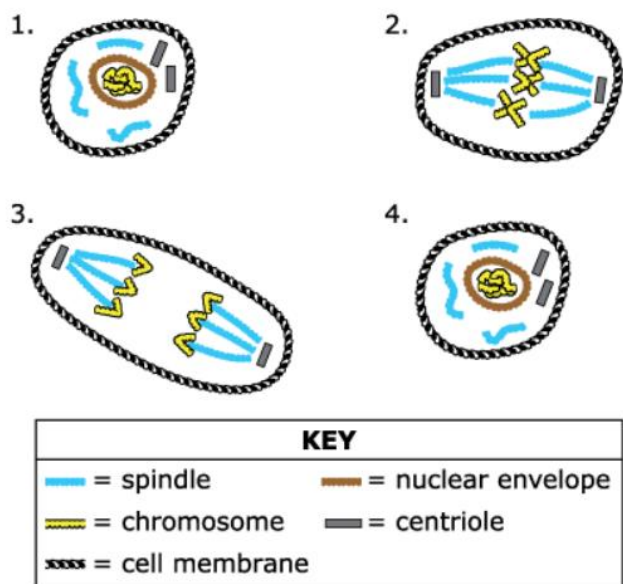
- ☐ A. a comparison of the anatomical structures of the leg bones of giant pandas and red pandas
- ☒ B. a comparison of DNA patterns in the genomes of giant pandas and red pandas
- ☐ C. a comparison of the fossilized ancestors of giant pandas and red pandas
- ☐ D. a comparison of the behaviors of giant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

Item Information		
Answer:	B	
Grade Level Expectation:	SC.HS.2.10	Evidence of common ancestry and diversity between species can be determined by examining variations including genetic, anatomical and physiological differences.
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 OECl CCC 1 P
Standard:	Life Science	

Item Set 1 – 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



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 Sample Student Responses	
Grade Level Expectation:	SC.HS.2.2	Growth and division of cells in complex organisms occurs by mitosis, which differentiates specific cell types.
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
Standard:	Life Science	

Scoring Rubric	
Points	Attributes
2	<p>The student's response should include:</p> <ul style="list-style-type: none"> An explanation of the function of mitosis. A description of how the student could correct the end result of mitosis in the model. <p>Student responses may include but are not limited to:</p> <ul style="list-style-type: none"> 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 <p>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.</p>
1	Student response demonstrates a partial understanding of the task.
0	Student response does not demonstrate an understanding of the task.

Sample Student Responses	
<i>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.</i>	
Points	
2	Sample Response
	<p>Sample A</p> <p>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.</p> <p>Sample B</p> <p>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.</p>
	Sample Annotation
	<p>Sample A</p> <ul style="list-style-type: none"> The response includes an explanation of the function of mitosis (<i>Mitosis is used by organisms to grow. It is when one cell multiplies into two cells</i>). 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 (<i>at the end there should be two cells and they should be identical</i>). <p>Sample B</p> <ul style="list-style-type: none"> The response includes an explanation of the function of mitosis (<i>the process that a person uses to make new skin, like when they have a wound</i>). 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 (<i>When mitosis is complete there should be two complete cells and they should both be exactly like the starting cell</i>).

1	Sample Response
	Sample A 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 B The function of mitosis is to split cells in half, so the model should show two cells at the end, not just one.
	Sample Annotation
0	Sample A <ul style="list-style-type: none"> The response includes an explanation of the function of mitosis (<i>create new cells that are identical to the parent cells so it can grow new tissue</i>). 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 <ul style="list-style-type: none"> The response includes a description of how the student could correct the end result of mitosis in the model (<i>the model should show two cells at the end, not just one</i>). 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 (<i>split cells in half</i>) 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.
	Sample Response
	Sample A The model is incorrect because it does not show the ribosomes.
0	Sample B Mitosis is when cells divide and become eggs. The model is incorrect because the final cell has too many chromosomes.
	Sample Annotation
	Sample A <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> 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 1 – Question 3 (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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Additional access roads do not have to be constructed, which will conserve wildlife habitats.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
The wind turbines generate low-frequency noise, which may interrupt people's sleep.	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Item Information		
Answer:	See Image	
Grade Level Expectation:	SC.HS.3.9	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
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
Standard:	Earth and Space Science	

Item Set 1 – Question 4 (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 Sample Student Responses	
Grade Level Expectation:	SC.HS.3.9	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
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
Standard:	Earth and Space Science	

Scoring Rubric	
Points	Attributes
2	<p>The student's response should include:</p> <ul style="list-style-type: none"> • 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. <p>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.</p>
1	Student response demonstrates a partial understanding of the task.
0	Student response does not demonstrate an understanding of the task.

Sample Student Responses	
<i>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.</i>	
Points	
2	Sample Response
	<p>Sample A 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.</p> <p>Sample B 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.</p>
	Sample Annotation
	<p>Sample A</p> <ul style="list-style-type: none"> • The response identifies a location that would benefit the most from a DWS rather than the installation of a local set of wind turbines (<i>Location C</i>). • The response explains why that location is the best selection for the DWS (<i>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</i>). <p>Sample B</p> <ul style="list-style-type: none"> • The response identifies a location that would benefit the most from a DWS rather than the installation of a local set of wind turbines (<i>Location C</i>). • The response explains why that location is the best selection for the DWS (<i>high impact on the ecosystem in this location ... where it could kill endangered species</i>).

1	Sample Response
	Sample A Location C because it says “low, high, medium, low.”
	Sample B Location C
	Sample Annotation
0	Sample A <ul style="list-style-type: none"> The response identifies a location that would benefit the most from a DWS rather than the installation of a local set of wind turbines (<i>Location C</i>). 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 <ul style="list-style-type: none"> The response identifies a location that would benefit the most from a DWS rather than the installation of a local set of wind turbines (<i>Location C</i>). The response does not explain why that location is the best selection for the DWS.
	Sample Response
	Sample A Location B because that is where the most people are.
	Sample B Location A because it is pretty in the mountains and a windmill would look nice there.
	Sample Annotation
	Sample A <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> 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 5 (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	
Grade Level Expectation:	SC.HS.3.9	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
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.
Standard:	Earth and Space Science	

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 turbines are needed, on average, to meet electricity production goals. This ultimately leads to 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 .

Item Information		
Answer:	See Sample Student Responses	
Grade Level Expectation:	SC.HS.3.9	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
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
Standard:	Earth and Space Science	

Item Set 1 – Question 7 (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

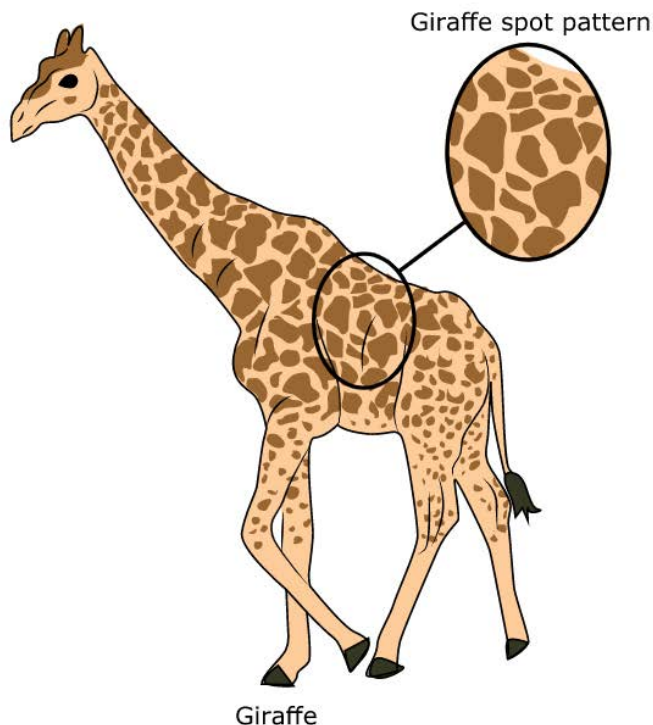
Item Information		
Answer:	See Sample Student Responses	
Grade Level Expectation:	SC.HS.3.9	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
Evidence Outcome:	SC.HS.3.9.b	Evaluate competing design solutions for developing, 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
Standard:	Earth and Space Science	

Scoring Rubric	
Points	Attributes
2	<p>The student's response should include:</p> <ul style="list-style-type: none"> 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. <p>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.</p>
1	Student response demonstrates a partial understanding of the task.
0	Student response does not demonstrate an understanding of the task.
Sample Student Responses	
<i>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.</i>	
Points	
2	<p>Sample Response 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.</p> <p>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.</p> <p>Sample Annotation Sample A Annotation</p> <ul style="list-style-type: none"> The response provides a comparison between the long-term effects of higher transportation costs and the long term benefit of greater electricity production (<i>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</i>). 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 (<i>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</i>). <p>Sample B Annotation</p> <ul style="list-style-type: none"> The response provides a comparison between the long-term effects of higher transportation costs and the long term benefit of greater electricity production (<i>\$2000 more a year in electricity than a windmill in location B and it cost \$10,000 extra to transport it</i>). Calling the wind turbine a “windmill” is acceptable. The response gives an explanation of how this comparison favors Location D instead of Location C (<i>then that is a savings of \$10000 over 10 years</i>). Using theoretical numbers is acceptable.
1	<p>Sample Response 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.</p>

0	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 Annotation
	Sample A Annotation <ul style="list-style-type: none"> The response provides a comparison between the long-term effects of higher transportation costs and the long term benefit of greater electricity production (<i>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</i>). The response does not give an explanation of how this comparison favors Location D instead of Location C.
	Sample B Annotation <ul style="list-style-type: none"> The response gives an explanation of how this comparison favors Location D instead of Location C (<i>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</i>). 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
	Sample Response
	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 B Response I would pick location D.
	Sample Annotation
	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 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

Item Set 1 – Question 8 (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?

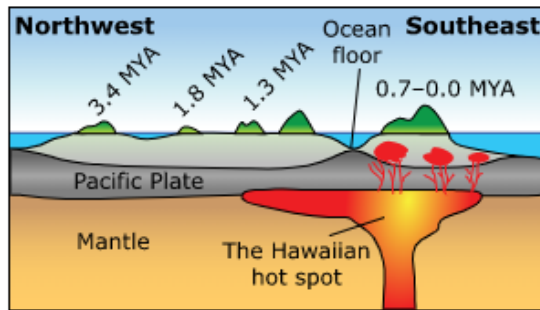
- ☐ A. How do wild giraffes' spot patterns compare with captive giraffes' spot patterns?
- ☐ B. How does the color of the spots on the calves' coats change as they grow?
- ☒ C. What role does DNA play in the spot patterns inherited by the calves?
- ☐ D. Can variation in spot patterns be used to identify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

Item Information		
Answer:	C	
Grade Level Expectation:	SC.HS.2.8	The characteristics of one generation are dependent upon the genetic information inherited from previous generations.
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
Standard:	Life Science	

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	
Grade Level Expectation:	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.
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.
Standard:	Earth and Space Science	

Item Set 2 – Question 2 (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	186

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.

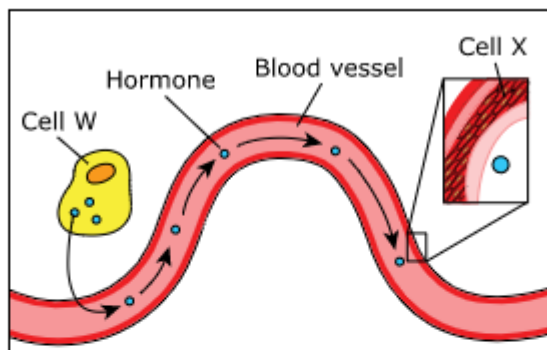
- ☐ A. Each object exerts the same force on Earth as Earth exerts on the object.
- ☐ B. Each object starts to move only after a force is applied to it.
- ☒ C. The forces are all in proportion to the masses they affect.
- ☐ D. The objects are all dropped from the same height.
- ☒ E. The objects all accelerate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

Item Information

Answer:	C, E	
Grade Level Expectation:	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.
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.
Standard:	Physical Science	

Item Set 2 – Question 3 (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



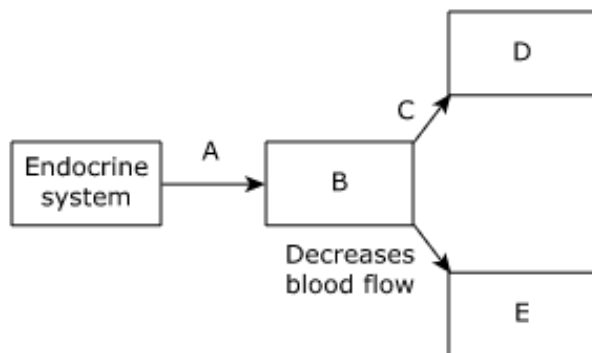
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Item Information

Answer:	See Image	
Grade Level Expectation:	SC.HS.2.1	DNA codes for the complex hierarchical organization of systems that enable life's functions.
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.
Standard:	Life Science	

Item Set 2 – Question 4 (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	
Grade Level Expectation:	SC.HS.2.1	DNA codes for the complex hierarchical organization of systems that enable life's functions.
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.
Standard:	Life Science	

Item Set 2 – Question 5 (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	
Grade Level Expectation:	SC.HS.2.1	DNA codes for the complex hierarchical organization of systems that enable life's functions.
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.
Standard:	Life Science	

Item Set 2 – Question 6 (TEI Inline Choice)

The students want to compare the data measured for each subject in the digestion investigation described in Part 2.

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

The students can better compare data if the ratio of the

energy content of the meal to the mass of the subject is

consistent for all the participants. This will help ensure that the data collected provides accurate evidence about how a subject's body systems work

together to maintain homeostasis.

Item Information		
Answer:	See Image	
Grade Level Expectation:	SC.HS.2.1	DNA codes for the complex hierarchical organization of systems that enable life's functions.
Evidence Outcome:	SC.HS.2.1.c	Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
Standard:	Life Science	

Item Set 2 – Question 7 (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 Sample Student Responses	
Grade Level Expectation:	SC.HS.2.1	DNA codes for the complex hierarchical organization of systems that enable life's functions.
Evidence Outcome:	SC.HS.2.1.c	Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
Standard:	Life Science	

Scoring Rubric	
Points	Attributes
2	<p>The student's response should include:</p> <ul style="list-style-type: none"> • 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. <p>Student responses may include but are not limited to:</p> <ul style="list-style-type: none"> • 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 Responses

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	
2	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 (<i>Plan C will provide the best evidence</i>) and explains why Plan C is the best choice for providing evidence for the effect of the feedback loop on homeostasis (<i>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</i>).
1	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 (<i>The plan that tests before eating, immediately after, ten minutes after, and 1 hour after eating</i>). 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
	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 2 – Question 8 (TEI Inline Choice)

Compare the trials with the lid on the container to the trials with the lid off the container.

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

For the low-heat trials, the difference between the

energy used



data in the two trials represents

the energy

transferred from



the system by escaping steam.

Item Information		
Answer:	See Image	
Grade Level Expectation:	SC.HS.1.7	Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
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.
Standard:	Physical Science	

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	
Grade Level Expectation:	SC.HS.1.7	Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
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.
Standard:	Physical Science	

Item Set 2 – Question 10 (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

heat lost to the surrounding environment and will the efficiency of energy transfer.

Item Information		
Answer:	See Image	
Grade Level Expectation:	SC.HS.1.9	Although energy cannot be destroyed, it can be converted to less useful forms as it is captured, stored and transferred.
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.
Standard:	Physical Science	

Item Set 2 – Question 11 (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 Sample Student Responses	
Grade Level Expectation:	SC.HS.1.9	Although energy cannot be destroyed, it can be converted to less useful forms as it is captured, stored and transferred.
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.
Standard:	Physical Science	

Scoring Rubric	
Points	Attributes
2	<p>The student's response should include:</p> <ul style="list-style-type: none"> • 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. <p>Student responses may include but are not limited to:</p> <ul style="list-style-type: none"> • 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 Responses

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	
2	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 (<i>electrical energy is converted into thermal energy</i>). An explanation of the limitation for converting all the available energy into usable energy is provided (<i>some of the thermal energy produced will be released into the surrounding environment and cannot be used to heat the water</i>).
1	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 (<i>the energy starts as electrical energy and is turned into thermal energy</i>). 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
	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 12 (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 Sample Student Responses	
Grade Level Expectation:	SC.HS.1.7	Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
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.
Standard:	Physical Science	

Scoring Rubric	
Points	Attributes
2	<p>The student's response should include:</p> <ul style="list-style-type: none"> • 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. <p>Student responses may include but are not limited to:</p> <ul style="list-style-type: none"> • 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: $382.6 \text{ Wh} - 261.3 \text{ Wh} = 121.3 \text{ Wh}$.
1	Student response demonstrates a partial understanding of the task.
0	Student response does not demonstrate an understanding of the task.

Sample Student Responses

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	
2	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: $382.6 \text{ Wh} - 261.3 \text{ Wh} = 121.3 \text{ Wh}$.
	Sample Annotation
	This response demonstrates a complete understanding of the task. The correct trial is identified [<i>the trial with low power (950 W) with the lid off</i>], and the approximate amount of lost energy is calculated (<i>subtracting the theoretical amount of energy to heat the water from the total amount of energy used in this trial: $382.6 \text{ Wh} - 261.3 \text{ Wh} = 121.3 \text{ Wh}$</i>).
1	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 (<i>The trial with low heat and the lid off lost the most energy</i>), but the approximate amount of lost energy is not calculated.
0	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 (<i>low heat and the lid on</i>). The approximate amount of lost energy is not calculated, numbers from the prompt are just compared.

Item Set 2 – Question 13 (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 Sample Student Responses	
Grade Level Expectation:	SC.HS.1.7	Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
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).
Standard:	Physical Science	

Scoring Rubric	
Points	Attributes
2	<p>The student's response should include:</p> <ul style="list-style-type: none"> • 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. <p>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.</p>
1	Student response demonstrates a partial understanding of the task.
0	Student response does not demonstrate an understanding of the task.

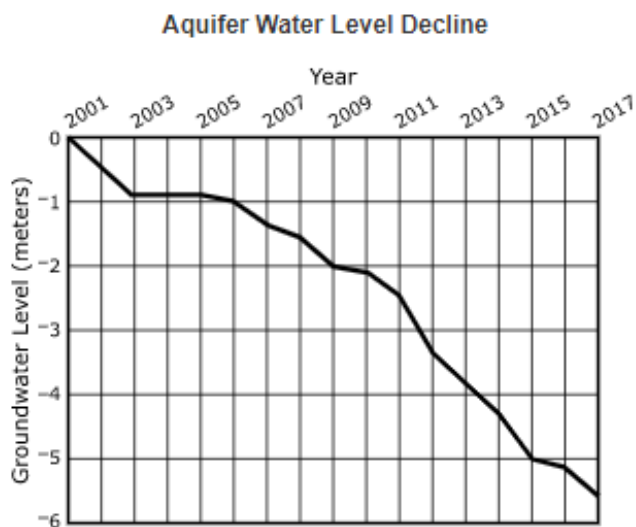
Sample Student Responses

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	
2	Sample Response
	<p>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.</p> <p>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).</p>
	Sample Annotation <p>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 (<i>adding 20 and 80, then dividing by 2</i>). The expected time is correct (<i>about 1,000 seconds</i>) and is explained (<i>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)</i>).</p>
1	Sample Response
	<p>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.</p>
	Sample Annotation <p>This response demonstrates a partial understanding of the task. The correct final temperature of the mixture of water samples A and B is given (<i>this time it will be at 50°</i>), 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 (<i>Subtract 1450 – 400 and the new time to boil the water is 1050 seconds</i>).</p>
0	Sample Response
	<p>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.</p>
	Sample Annotation <p>This response does not demonstrate an understanding of the task. The final water temperature is incorrect (<i>now it's at 80°</i>). The time for the water to boil is incorrect due to a faulty strategy (<i>300 seconds to go up from 20° to 40°, so from 80° to 100° will take 300 seconds</i>). Note that the graphs shown for containers without lids are not linear, so this approach is incorrect.</p>

Item Set 2 – Question 14 (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.

- ☒ 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.
- ☒ D. Farmers grow crops that require less irrigation.
- ☐ E. The community relocates to another area.

Item Information		
Answer:	A, D	
Grade Level Expectation:	SC.HS.3.9	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
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.
Standard:	Earth and Space Science	

Item Set 2 – Question 15 (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	
Grade Level Expectation:	SC.HS.3.9	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
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.
Standard:	Earth and Space Science	

Item Set 2 – Question 16 (TEI Inline Choice)

A student decides to further investigate the types of wells described in Part 2. The student wants to test rock types to determine their effectiveness as aquifers. The student uses these materials:

- samples of four different rock types
- water
- graduated cylinder
- timer
- scale

The student submerges each of the four rock samples individually in 500 milliliters (mL) of water.

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

To determine which of the rock types in the investigation would be the most efficient aquifer, the student should remove each sample from the water and measure the to find the

.

Item Information		
Answer:	See Image	
Grade Level Expectation:	SC.HS.3.6	The planet's dynamics are greatly influenced by water's unique chemical and physical properties.
Evidence Outcome:	SC.HS.3.6.a	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
Standard:	Earth and Space Science	

Item Set 2 – Question 17 (TEI Inline Choice)

One of the most important needs for early settlers was a source of water.

Using the information in Part 2, select one correct response from each drop-down menu to complete the sentences.

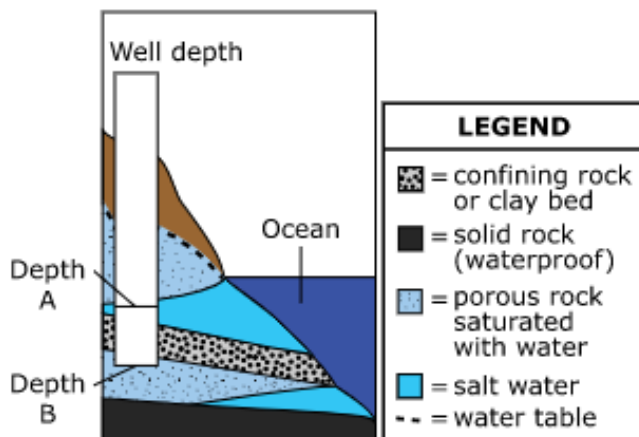
People were more likely to settle in areas where the artesian pressure surface of a was ground level.

This allowed people to use local groundwater resources without creating technology to .

Item Information		
Answer:	See Image	
Grade Level Expectation:	SC.HS.3.9	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
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.
Standard:	Earth and Space Science	

Item Set 2 – Question 18 (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 Sample Student Responses	
Grade Level Expectation:	SC.HS.3.9	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
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.
Standard:	Earth and Space Science	

Scoring Rubric	
Points	Attributes
2	<p>The student's response should include:</p> <ul style="list-style-type: none"> • A cost comparison between the wells at Depth A and Depth B. • A performance comparison between the wells at Depth A and Depth B. <p>Student responses may include but are not limited to:</p> <ul style="list-style-type: none"> • 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.

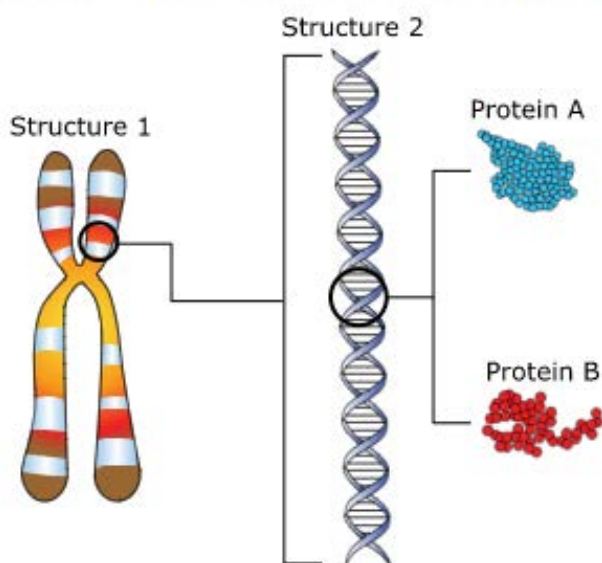
Sample Student Responses

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	
2	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 (<i>It will cost more to drill to Depth B</i>). A correct performance comparison is provided (<i>A well at Depth B will need less pumping ... there would be less salt water mixed in with the fresh water</i>), addressing both the salinity of the water and the necessity of a pump for both depths.
1	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 (<i>depth B would be more expensive than depth A</i>). The performance comparison is incorrect (<i>B ... will be harder to pump the water out</i>) and incomplete because it lacks a comparison of the salinity of the water at each depth.
0	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 (<i>depth A will probably cost more</i>). 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 19 (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 Sample Student Responses	
Grade Level Expectation:	SC.HS.2.8	The characteristics of one generation are dependent upon the genetic information inherited from previous generations.
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.
Standard:	Life Science	

Scoring Rubric	
Points	Attributes
2	<p>The student's response should include:</p> <ul style="list-style-type: none"> • The identification of Structure 1 and Structure 2. • An explanation of how different traits arise in offspring from proteins formed from these structures. <p>Student responses may include but are not limited to:</p> <ul style="list-style-type: none"> • 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 Responses

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	
2	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 (<i>Structure 1 is a chromosome, and Structure 2 is the DNA found on the chromosome</i>) and a complete explanation of how different traits arise from proteins formed by these structures is provided (<i>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</i>).
1	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 (<i>Parent pass their traits ... on their DNA. The DNA says what protein it will make</i>) is provided. Neither structure is identified.
0	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.