

# CALIFORNIA

Assessment of Student Performance and Progress

---



California Assessment of  
Student Performance and Progress

# California Science Test Practice Items Scoring Guide

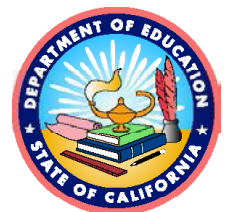
---

# High School

2018-19 Administration



*Measuring the Power of Learning.™*



# Table of Contents

<a href="#"><u>Introduction to Practice Test Answer Guide</u></a>	<a href="#"><u>1</u></a>
<a href="#"><u>Example of Metadata</u></a>	<a href="#"><u>2</u></a>
<a href="#"><u>High School Practice Test Items</u></a>	<a href="#"><u>3</u></a>

---

## Introduction to Practice Test Answer Guide

This California Science Test (CAST) practice test items scoring guide offers details about the items, student response types, correct responses, and related scoring considerations for the practice test items. These items have been selected to show some of the new approaches to measuring the California Next Generation Science Standards (CA NGSS) that can be found in the assessment. The practice test items are not fully representative of all possible item types included in the CAST. The practice test covers a selection of items from performance expectations in high school.

The following information is presented along with each item:

**Performance Expectations (PE) Code:** References the assessable evidence statements of what students should know and be able to do.

**Science and Engineering Practices (SEP):** Descriptions of behaviors that scientists and engineers engage in as they investigate the natural world and design solutions, respectively.

**Disciplinary Core Ideas (DCI):** Essential ideas in the science disciplines that all students should understand.

**Crosscutting Concepts (CCC):** Interdisciplinary skills that unify the study of science and engineering through common application across fields.

**Depth of Knowledge (DOK):** A measure of complexity that considers the students' cognitive process in response to an item (There are four DOK levels, with 4 being the highest.)

**Item-Level Claim Statement (ILCS):** A brief statement that illustrates how an item aligns to the PE through at least two of the dimensions (An ILCS is included with each item to help item reviewers (1) identify the intent of the alignment, (2) determine if the alignment is appropriate and valid, and (3) identify the content reflected in item-level specifications.)

**Item and Stimulus:** Item represents the question being asked, while stimulus is supporting information, graphics, animation or simulation included with some items.

**Answer Key:** The expected student response or example response including score point value

**Rubric and Exemplar:** Rubric explains what is needed for each score point. Exemplars give a sample response from a student.

While each item is aligned to a specific PE through its dimensions, certain items, based on their contexts, incorporate aspects of environmental literacy outlined in the Environmental Principles and Concepts adopted by the State Board of Education in 2004. The items in this practice test are not fully representative of the full range of ways items can incorporate environmental literacy.

The practice test items will include numbered instructional text preceding the first item.

## Introduction to Practice Test Answer Guide

Each item has a metadata table as shown. Metadata contains the specific information on the alignment of the item to the NGSS standards. The item number in the table preceding each item corresponds to the sequence number of the item as it appears in the practice test.

### Example of Metadata

Item	Grade	PE	SEP	DCI	CCC	DOK
2	High School	HS-LS4-4	6. Constructing Explanations and Designing Solutions	LS4.C Adaptation	2. Cause and Effect	3

**ILCS:** Construct an explanation based on evidence for how natural selection leads to changes in traits in populations.

## High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
2	High School	HS-LS4-4	6. Constructing Explanations and Designing Solutions	LS4.C Adaptation	2. Cause and Effect	3

**ILCS:** Construct an explanation based on evidence for how natural selection leads to changes in traits in populations.

The leaf beetle, *Chrysomela aeneicollis*, lives in the Sierra Nevada Mountains of California. Scientists studying the beetles found that exposure to high temperatures during the summer, when the eggs are laid and the larvae are developing, causes physiological stress. The impact is on metabolic enzymes and heat shock protein expression. One allele, *Pgi-4*, increased in frequency in the beetle population that was exposed to hotter, drier summers in the Sierra Nevada Mountains.

Complete the sentence about this change by selecting the correct words from the menus.

If the temperatures in the Sierra Nevada Mountains continue to increase, the frequency of the *Pgi-4* allele is expected to  as a result of .

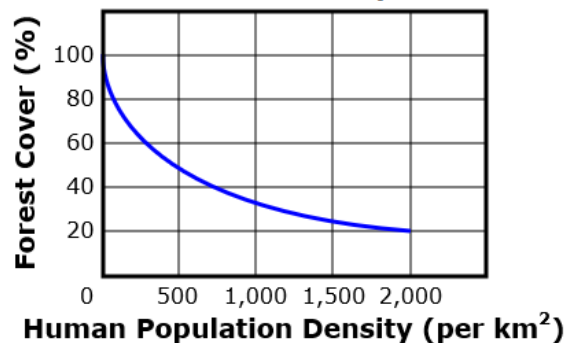
**Key:** First drop-down menu: increase. Second drop-down menu: natural selection. (1 point)

Item	Grade	PE	SEP	DCI	CCC	DOK
3	High School	HS-ESS3-3	5. Using Mathematics and Computational Thinking	ESS3.C Human Impacts on Earth Systems	7. Stability and Change	2

**ILCS:** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

Students are investigating the relationship between human population density and biodiversity. The amount of forest cover was used as a measure of the biodiversity of an area. The students averaged human population density and forest cover from locations with a range of population densities. The graph shows the students' results.

**Forest Cover and Human Population Density**



**Part A**

Select a phrase from the menu to complete the sentence.

Based on the graph, if the population density increases from 1 to 500 people/km<sup>2</sup>, the forest cover will likely  in that area.

**Part B**

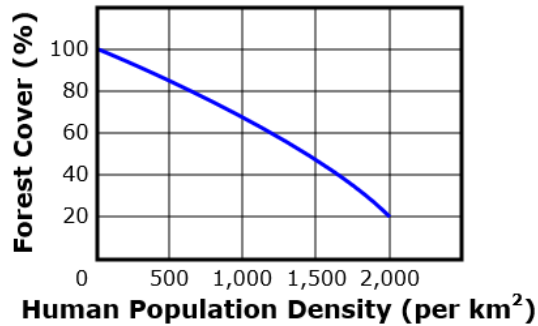
The students identified four resource management strategies intended to help preserve forest cover and maintain biodiversity.

The students then ran computer simulations to graphically compare the different resource management strategies.

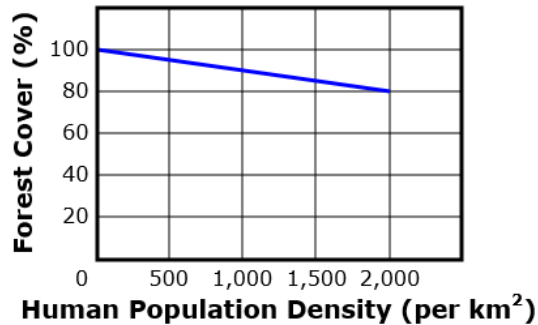
*Item continues on the next page.*

Which graph shows results for a resource management strategy that will **best** preserve forest cover as population density increases?

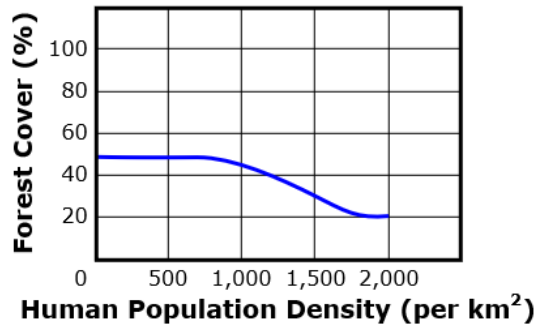
(A)



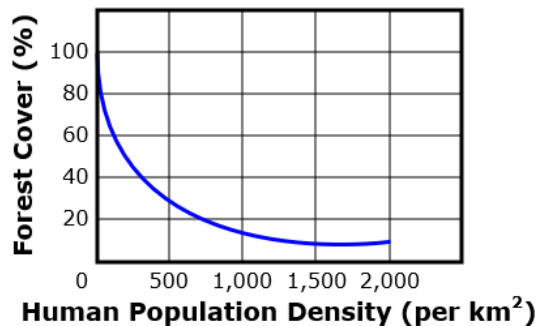
(B)



(C)



(D)



Key follows on the next page.

## High School Practice Test Items

---

**Key:**

**Part A:** Drop-down menu: decrease by about 50%. (1 point)

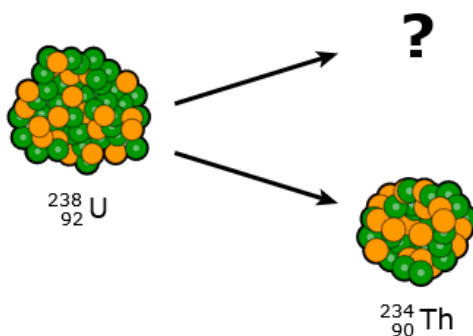
**Part B:** B (1 point)



Item	Grade	PE	SEP	DCI	CCC	DOK
4	High School	HS-PS1-8	2. Developing and Using Models	PS1.C Nuclear Processes	5. Energy and Matter	2

**ILCS:** Select the relevant components to complete the model by applying the scientific principle of nucleon conservation.

A uranium nucleus ( ${}^{238}_{92}\text{U}$ ) decays into a thorium nucleus ( ${}^{234}_{90}\text{Th}$ ) and another particle, as shown in the figure.



What is the other particle produced by the decay?

- (A)  ${}^2_1\text{H}$
- (B)  ${}^4_2\text{He}$
- (C)  ${}^{119}_{46}\text{Pd}$
- (D)  ${}^{234}_{90}\text{Th}$

**Key:** B (1 point)

## High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
5	High School	HS-ESS2-5	3. Planning and Carrying Out Investigations	ESS2.C The Roles of Water in Earth's Surface Processes	6. Structure and Function	3

**ILCS:** Identify the design that will provide the best evidence to determine the amount and type of sediment entering the stream.

Students noticed that a nearby pond, fed by a single stream, was filling up with sediment. The students want to determine what factors are contributing to the amount and type of sediment entering the pond. Which investigation is **most likely** to produce data that will help answer their questions?

- Ⓐ Measure the depth of the sediments in the center of the pond once a week during the school year.
- Ⓑ Collect and measure the mass of particles carried by the stream in one minute and then in ten minutes.
- Ⓒ Collect and measure the mass of clay particles, silt particles, sand grains, and small pebbles carried by the stream at different stream flow velocities.
- Ⓓ Obtain samples from different depths in the sediments at the bottom of the pond and determine how the sizes and amounts of particles have changed over time.

**Key:** C (1 point)

Item	Grade	PE	SEP	DCI	CCC	DOK
6	High School	HS-LS1-6	6. Constructing Explanations and Designing Solutions	LS1.C Organization for Matter and Energy Flow in Organisms	5. Energy and Matter	3

**ILCS:** Construct an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules combine to form other large molecules.

A biochemist conducted an experiment to follow the movement of glucose molecules in animal cells. Glucose with radioactively labeled carbon atoms was added to a culture of liver cells growing in a Petri dish. Over the next 18 hours, the biochemist assessed selected biomolecules in the culture for radioactivity. The results are shown in the table.

**Presence of Radioactive Carbon**

Biomolecule	3 Hours	6 Hours	9 Hours	12 Hours	15 Hours	18 Hours
Glucose	✓	✓	✓	✓		
Glycogen		✓	✓	✓	✓	✓

Explain how adding labeled glucose molecules to the culture resulted in labeled glycogen **and** describe what happened to the labeled glucose molecules during the 18-hour period. Enter your answer in the box provided.

B I U I<sub>x</sub>
☰ ☰ ☰ ☰
✂ 📄 📄 ↶ ↷
ABC English Ω

**2 point**

**Exemplar:**

The glucose molecules were incorporated into (or stored in) glycogen within 6 hours. Some of the glucose molecules were broken down and used for energy. All of the labeled glucose was either used up (metabolized) or stored by 18 hours.

**Rubric:**

The response explains that glucose is incorporated into or turned into glycogen. AND

The response explains that it can be used/broken down for energy. Further, there must be an indication that these processes take time, which can be seen in the table.

*Rubric continues on the next page.*

**1 point**

**Exemplar:**

The glucose molecule was incorporated into (or turned into) glycogen within 6 hours. OR  
Some of the glucose molecules were broken down and used for energy.

**Rubric:**

The response explains that glucose is incorporated into or turned into glycogen. OR

The response explains that it can be used/broken down for energy. Further, there must be an indication that these processes take time, which can be seen in the table.

**0 point**

**Exemplar:**

The glucose was turned into other molecules. OR

The glucose molecules dissolved because they are radioactive.

**Rubric:**

A 0-point response attempts to answer the prompt but is incorrect.

Item	Grade	PE	SEP	DCI	CCC	DOK
7	High School	HS-ESS1-3	8. Obtaining, Evaluating and Communicating Information	ESS1.A The Universe and Its Stars	5. Energy and Matter	3

**ILCS:** Describe how factors such as composition and temperature affect the rate of nuclear fusion and energy production.

A student is learning about the life cycles of low-mass and high-mass stars and creates a chart comparing the properties of the stars.

Complete the chart by placing a check mark in the box or boxes in each row to indicate if the property applies to low-mass stars, high-mass stars, or both.

	Low-mass stars	High-mass stars
Has a higher core temperature during main sequence stage	<input type="checkbox"/>	<input type="checkbox"/>
Spends a longer time on the main sequence	<input type="checkbox"/>	<input type="checkbox"/>
Burns hydrogen at a faster rate during main sequence stage	<input type="checkbox"/>	<input type="checkbox"/>
Spends the majority of its lifetime burning hydrogen in its core	<input type="checkbox"/>	<input type="checkbox"/>
Can create elements heavier than iron during supernova event	<input type="checkbox"/>	<input type="checkbox"/>

**Key:**(1 point)

	Low-mass stars	High-mass stars
Has a higher core temperature during main sequence stage	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Spends a longer time on the main sequence	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Burns hydrogen at a faster rate during main sequence stage	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Spends the majority of its lifetime burning hydrogen in its core	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Can create elements heavier than iron during supernova event	<input type="checkbox"/>	<input checked="" type="checkbox"/>

## High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
8	High School	HS-PS4-1	5. Using Mathematics and Computational Thinking	PS4.A Wave Properties	2. Cause and Effect	2

**ILCS:** Describe how wavelength is related to the change in the medium.

Laser light of wavelength 785 nm in air travels from air (index of refraction = 1) into a glass block (index of refraction = 1.5). The frequency of the light does not change when the light enters the glass. How does the wavelength of the light change, if at all, when the light enters the glass, and what reasoning supports this claim?

- Ⓐ The wavelength stays the same, because the wavelength can only change if the frequency changes.
- Ⓑ The wavelength stays the same, because the speed of light is constant and the frequency does not change.
- Ⓒ The wavelength decreases, because the speed of the light in the glass is less than the speed of light in air and the frequency does not change.
- Ⓓ The wavelength decreases, because the speed of the light in the glass is greater than the speed of light in air and if the speed increases, the wavelength must decrease.

**Key:** C (1 point)

Item	Grade	PE	SEP	DCI	CCC	DOK
9	High School	HS-LS3-3	4. Analyzing and Interpreting Data	LS3.B Variation of Traits	3. Scale, Proportion, and Quantity	2

**ILCS:** Calculate the predicted genotypic ratios of offspring.

In a particular species of plant, yellow seed color is dominant to green seed color. Two plants of this species that are heterozygous for seed color are crossed.

What is the predicted ratio for seed color in the offspring of this cross?

- Ⓐ 1 yellow : 3 green
- Ⓑ 1 yellow : 1 green
- Ⓒ 3 yellow : 1 green
- Ⓓ 3 yellow : 2 green

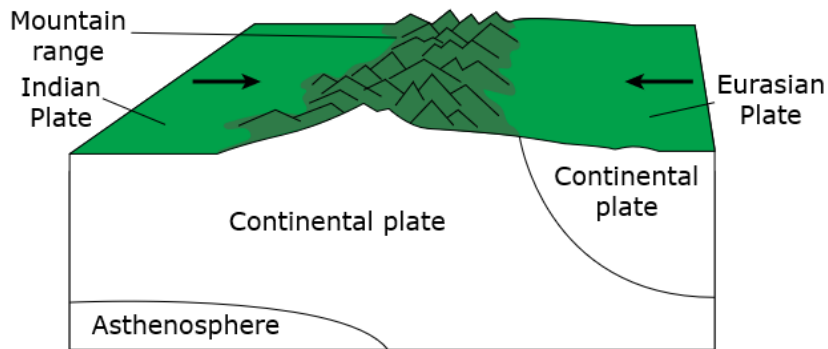
**Key:** C (1 point)

High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
10	High School	HS-ESS2-1	2. Developing and Using Models	ESS2.A Earth Materials and Systems	7. Stability and Change	3

**ILCS:** Describe how a model illustrates or explains the internal and surface processes that produced a geological feature.

This diagram shows the boundary between the Indian Plate and the Eurasian Plate.



Select the **best** terms from the menus to complete the following statements.

The mountains were formed as a result of the Indian Plate  the Eurasian Plate.

Over time, the effects of  will counteract the process that builds the mountains.

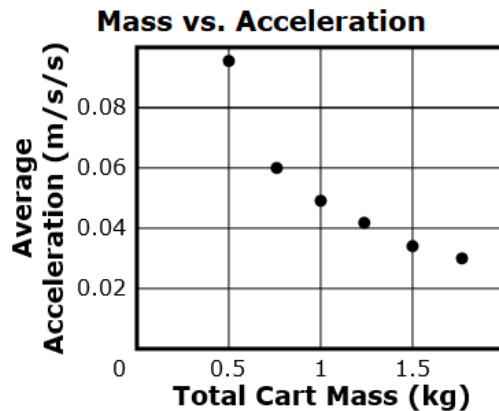
**Key:** First drop-down menu: colliding with. Second drop-down menu: weather and erosion. (1 point)



Item	Grade	PE	SEP	DCI	CCC	DOK
11	High School	HS-PS2-1	4. Analyzing and Interpreting Data	PS2.A Forces and Motion	2. Cause and Effect	2

**ILCS:** Identify the relationship between mass and acceleration.

A student performs an experiment in which a cart is pulled across a table by exerting a net force of 0.05 N on the cart. Different amounts of mass are added to the cart for each trial. The graph shows data from the experiment.



Based on the results from the experiment, what claim can the student make about the relationship between net force, acceleration, and mass?

- (A) Objects with smaller mass experience a larger acceleration and therefore a larger net force.
- (B) Objects with larger mass experience a smaller acceleration and therefore a smaller net force.
- (C) Objects with larger mass experience a smaller acceleration when the net force is the same.
- (D) Objects with smaller mass experience a smaller acceleration when the net force is the same.

**Key:** C (1 point)

## High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
12	High School	HS-ETS1-1	1. Asking Questions and Defining Problems	ETS1.A Defining and Delimiting Engineering Problems	N/A	3

**ILCS:** Select questions that could help determine criteria or constraints for design solutions that will help in reducing carbon dioxide emissions. Identify different variations on the problem definition that highlight the concerns of the community.

For a certain farming community in California, a water shortage is predicted if the average global temperature rises by 1°C. The residents of this community rely on private vehicles powered by fossil fuels for transportation because there is no public transportation system. Farm vehicles powered by diesel fuel are used to harvest the crops and get them to market.

Residents of the farming community want to reduce their impact on global temperature increases by reducing their carbon dioxide (CO<sub>2</sub>) emissions. They asked the town planners to propose some possible solutions that will address their transportation concerns and reduce the amount of CO<sub>2</sub> released into the atmosphere. Two potential solutions have been proposed:

- Solution 1: Restrict the use of private vehicles powered by fossil fuels on public roads.
- Solution 2: Promote vehicles powered by renewable energy sources to harvest the crops and get them to market.

### **Part A**

Select **two** questions that residents of the farming community could ask to **quantitatively** evaluate the proposed solutions.

- Does this plan take into consideration damage to the crops caused by extreme weather events?
- Will this plan allow our community members to independently select oil suppliers?
- Will this plan increase our farming community's access to new varieties of seeds?
- Does this plan allow the farms in our community to continue to be profitable?
- Does this plan allow for a significant reduction in the use of diesel fuel?

*Item continues on the next page.*

**Part B**

Place a check mark in the boxes to indicate whether each of the two potential solutions addresses the stated transportation concerns of the farming community, the global problem of increasing CO<sub>2</sub> emissions, or both.

	<b>Addresses transportation concerns of farming community</b>	<b>Addresses global problem of increasing CO<sub>2</sub> emissions</b>
Solution 1: Restrict the use of private vehicles powered by fossil fuels on public roads.	<input type="checkbox"/>	<input type="checkbox"/>
Solution 2: Promote vehicles powered by renewable energy sources to harvest the crops and get them to market.	<input type="checkbox"/>	<input type="checkbox"/>

**Key:**

**Part A:** Fourth and fifth options. (1 point)

**Part B:** (1 point)

	<b>Addresses transportation concerns of farming community</b>	<b>Addresses global problem of increasing CO<sub>2</sub> emissions</b>
Solution 1: Restrict the use of private vehicles powered by fossil fuels on public roads.	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Solution 2: Promote vehicles powered by renewable energy sources to harvest the crops and get them to market.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

## High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
13	High School	HS-LS4-6	5. Using Mathematics and Computational Thinking	LS4.D Biodiversity and Humans	2. Cause and Effect	2

**ILCS:** Identify components in a simulation that depict the effects of human activity on bird biodiversity.

**Environmental Principle II:** The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.

Students are given an assignment to design a simulation that will model effects of human activity on biodiversity in a particular town. A student decides to model changes in the biodiversity of bird species caused by human activity in a forested park next to the school. The park is home to many native bird species. Near the park is a housing development and an industrial area.

What **three** components should the students include in their simulation to **best** understand the effects of human activity on biodiversity?

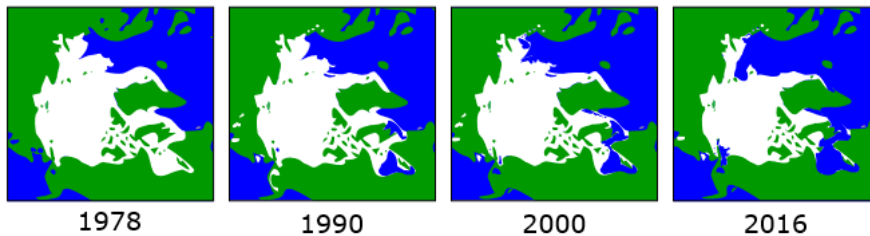
- size of the park
- annual rainfall in the town
- number of native bird species in the park
- projected population growth in the town
- number of native herbivore species in the park

**Key:** First, third, and fourth options. (1 point)

Item	Grade	PE	SEP	DCI	CCC	DOK
14	High School	HS-ESS3-5	4. Analyzing and Interpreting Data	ESS3.D Global Climate Change	7. Stability and Change	2

**ILCS:** Predict changes to the Arctic sea ice based on probability and describe the patterns shown in the data over time.

Scientists studied the extent of Arctic sea ice from 1978 to 2016. Observations from selected years are shown in the maps. The white areas show the extent of the sea ice in November of the indicated year. The dark blue areas are ice-free ocean and the green areas are continents in all of the maps.



**Part A**

Based on the Arctic sea ice images from 1978 to 2016, what is **most likely** going to occur from 2017 to 2027?

- (A) Arctic sea ice will move to other parts of the ocean.
- (B) Arctic sea ice will freeze and melt at the same rate.
- (C) Arctic sea ice will continue to melt at an increasing rate.
- (D) Arctic sea ice will continue to expand until it exceeds its 1978 extent.

**Part B**

Use the menus to complete the statement.

Melting Arctic sea ice contributes to a positive feedback loop in the Arctic. As Arctic sea ice melts,  sunlight is reflected and the temperature of the Arctic Ocean .

*Key follows on the next page.*

**Key:**

**Part A:** C (1 point)

**Part B:** First drop-down menu: less. Second drop-down menu: increases. (1 point)

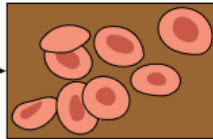

Item	Grade	PE	SEP	DCI	CCC	DOK
15	High School	HS-LS1-1	6. Constructing Explanations and Designing Solutions	LS1.A Structure and Function	6. Structure and Function	3

**ILCS:** Explain how the differing nucleotide sequences can cause red blood cells to differ in phenotype due to the proteins encoded by these sequences.

Sickle-cell disease is a group of genetic disorders that affect hemoglobin, which is the protein in red blood cells that binds to oxygen. The change to the hemoglobin molecule causes the red blood cells to have a crescent or sickled shape. The diagram shows a fragment of the DNA sequence for hemoglobin in a person without sickle-cell disease and in a person with the disease.

**Part A**

Select the amino acid change that reflects the mutation leading to sickled red blood cells.

<b>DNA sequence</b>	C A C G T G	G T G C A C	G A C C T G	T G A A C T	G G A C C T	C T C G A G	C T C G A G	 Normal red blood cells
<b>Amino acid sequence</b>	Valine	Histidine	Leucine	Threonine	Proline	Glutamic acid	Glutamic acid	
<b>DNA sequence</b>	C A C G T G	G T G C A C	G A C C T G	T G A A C T	G G A C C T	C A C G T G	C T C G A G	 Sickled red blood cells
<b>Amino acid sequence</b>	Valine	Histidine	Leucine	Threonine	Proline	Valine	Glutamic acid	

**Part B**

Complete the sentences by selecting terms from the menus that **best** explain how a change in the DNA sequence can cause sickle-cell disease.

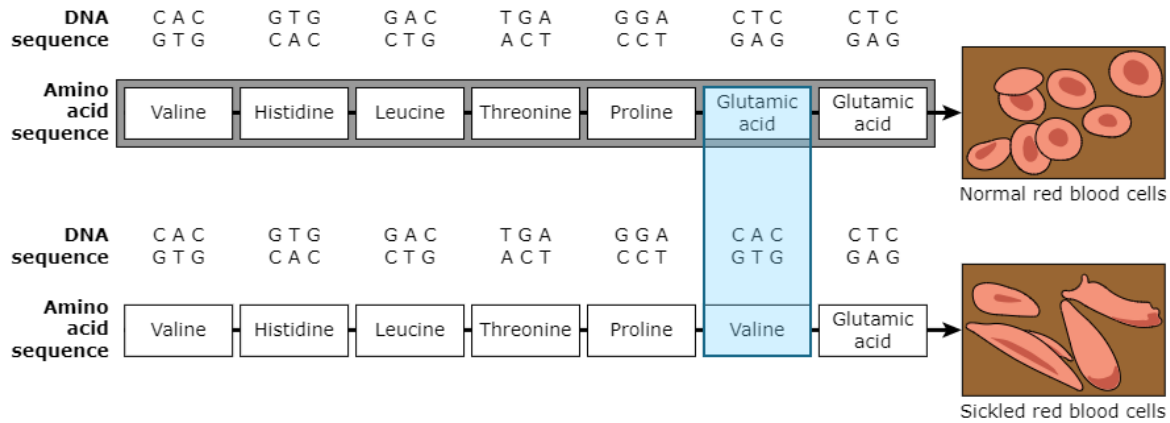
Each amino acid in a protein is coded for by  nucleotides in the DNA. In sickled red blood cells,  occurred, causing a different hemoglobin protein to be produced.

Key follows on the next page.

# High School Practice Test Items

## Key:

### Part A: Glutamic acid/Valine. (1 point)



### Part B: First drop-down menu: three. Second drop-down menu: a point mutation. (1 point)



Item	Grade	PE	SEP	DCI	CCC	DOK
16	High School	HS-ETS1-4	5. Using Mathematics and Computational Thinking	ETS1.B Developing Possible Solutions	4. Systems and System Models	2

**ILCS:** Identify patterns of damage caused by earthquakes in buildings of different heights based on data from a simulation.

A student uses a computer simulation to investigate the effect of earthquakes on buildings. The simulation shows damage to buildings of similar construction except for their height. The simulation settings and the data collected from the simulation are shown.

Type of soil — Soft clay  
Magnitude of Earthquake — 8.0

Height of Building (floors/stories)	Degree of Damage
1	Minimal
3	Minimal
5	Severe
7	Severe
9	Severe
11	Moderate
13	Moderate
15	Moderate
17	Minimal
19	Minimal

Select terms from the menus to create a correct conclusion that is based on the simulation.

A building of a height of  floors could be expected to receive a severe amount of damage.

The severe damage to certain buildings is **most likely** due to .

*Key follows on the next page.*

## High School Practice Test Items

---

**Key:** First drop-down menu: 8. Second drop-down menu: the frequency of the building vibrations. (1 point)

Item	Grade	PE	SEP	DCI	CCC	DOK
17	High School	HS-ESS1-4	5. Using Mathematics and Computational Thinking	ESS1.B Earth and the Solar System	3. Scale, Proportion, and Quantity	2

**ILCS:** Evaluate how a comet’s acceleration and/or force of attraction between the Sun and comet change with respect to the change in the comet’s distance and/or mass.

A comet is in an elliptical orbit around the Sun. Select from the menus to **best** describe what happens at locations in the orbit where the comet is getting closer to the Sun.

As the comet approaches the Sun, the gravitational force between the comet and the Sun  and the comet .

**Key:** First drop-down menu: increases. Second drop-down menu: speeds up. (1 point)

## High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
18	High School	HS-LS4-5	7. Engaging in Argument from Evidence	LS4.C Adaptation	2. Cause and Effect	2

**ILCS:** Describe the conditions under which a claim about temperature effect on sugar maple tree distribution can be supported.

**Environmental Principle II:** The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.

Results from a wide range of climate model simulations suggest that Earth’s average surface temperature could be between 1.1 and 5.4°C warmer in 2100 than it was in 2015. Some species, such as sugar maple trees, are adapted to survive cooler temperatures and have historically occupied northern parts of North America. Scientists claim that rising average temperatures will change the distribution of sugar maple trees in North America.

In addition to global surface temperature data, which data, if collected, would **best** support or refute the claim?

- Ⓐ The soil temperature should be measured daily for one year at two separate locations.
- Ⓑ Core samples of the largest sugar maple trees should be taken to determine how old the trees are.
- Ⓒ The total number of acres of forested land throughout the range of sugar maple trees should be recorded annually.
- Ⓓ Sample sites should be set up throughout the range of sugar maple trees and the number of sugar maple trees counted every five years.

**Key:** D (1 point)

Item	Grade	PE	SEP	DCI	CCC	DOK
19	High School	HS-ETS1-3	6. Constructing Explanations and Designing Solutions	ETS1.B Developing Possible Solutions	N/A	3

**ILCS:** Select the best alternative solution from among multiple solutions of renewable resources, based on their strengths and weaknesses, in providing electricity.

A town council of a small town in Southern California investigates the use of renewable sources of energy to generate electricity. They research both solar panels and wind turbines and collect the data in the table. Neither turbines nor solar panels release CO<sub>2</sub> during their normal operation; however, CO<sub>2</sub> is emitted during their manufacture.

	One Wind Turbine	40,000 Solar Panels
Energy consumed during manufacturing (in kWh)	4,300,000	23,100,000
Total mass of carbon dioxide (CO <sub>2</sub> ) released during manufacturing (in kg)	20,000	9,080,000
Total annual energy generated (in kWh/year)	6,400,000	6,400,000
Annual maintenance cost (in dollars)	140,000	0

The council determines that it requires about 40,000 solar panels to produce the same amount of energy per year as one wind turbine produces per year. Assume a 20-year lifetime for both turbines and solar panels.

Based on the table, complete these sentences by selecting the **best** phrases from the menus.

If the main goal of the town is to reduce the carbon dioxide (CO<sub>2</sub>) released into the atmosphere, then the town council should select  because the amount of CO<sub>2</sub>  is lower.

If the main goal of the town is to reduce maintenance costs, then the town council should select .

**Key:** First drop-down menu: wind turbines. Second drop-down menu: released during manufacturing. Third drop-down menu: solar panels. (1 point)

## High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
20	High School	HS-LS1-3	3. Planning and Carrying Out Investigations	LS1.A Structure and Function	7. Stability and Change	3

**ILCS:** Identify what is to be recorded as useful data for an investigation on the effect of exercise on heart rate.

Students in a class are designing an investigation to determine the effect running on a treadmill has on heart rate. They decide to have several students run for 20 minutes on a treadmill.

Which **two** data sets **must** the students collect in order to determine the effect exercise has on heart rate?

- the student's age
- the student's weight
- the student's resting heart rate prior to exercising
- the student's heart rate after running on the treadmill
- the distance the student can run on the treadmill in 20 minutes

**Key:** Third and fourth options. (1 point)

Item	Grade	PE	SEP	DCI	CCC	DOK
21	High School	HS-ESS3-4	6. Constructing Explanations and Designing Solutions	ETS1.B Developing Possible Solutions	7. Stability and Change	3

**ILCS:** Identify the best design from among multiple designs based on a prioritized list of criteria (e.g., maximize pollutant in wastewater, cost, aesthetics, etc.) on wastewater treatment capacities.

A small city in California is growing and needs to expand its wastewater treatment capacity. Currently the city has a treatment plant with open tanks that releases the treated effluent into a nearby creek. The city manager asks the wastewater treatment department to prioritize criteria for plans to expand the treatment plant.

The wastewater treatment department sets the following priorities in order of importance:

1. The system must be closed to reduce smell for nearby neighborhoods.
2. The operating costs must be under \$340,000 per month.
3. The wastewater must be treated so that the nitrate ion concentration in the effluent does not exceed 0.5 mg/L to prevent algal blooms in the creek.

Three different construction companies submit plans to expand the wastewater treatment plant.

*Item continues on the next page.*

## High School Practice Test Items

### Part A

This table shows the prioritized criteria and information about each plan. Select the parts of each plan that meet the criteria set by the city manager.

Priority	Criteria	Plan A	Plan B	Plan C
1	Open or closed system	Open	Closed	Closed
2	Cost per month for operating wastewater treatment plant	\$320,000	\$335,000	\$345,000
3	Nitrate ion concentration in wastewater effluent	0.4 mg/L	0.6 mg/L	0.4 mg/L

### Part B

Select a plan from the menu to complete the sentence.

Based on the prioritized order of the criteria, the city manager should accept  .

#### Key:

#### Part A: (1 point)

Priority	Criteria	Plan A	Plan B	Plan C
1	Open or closed system	Open	Closed	Closed
2	Cost per month for operating wastewater treatment plant	\$320,000	\$335,000	\$345,000
3	Nitrate ion concentration in wastewater effluent	0.4 mg/L	0.6 mg/L	0.4 mg/L

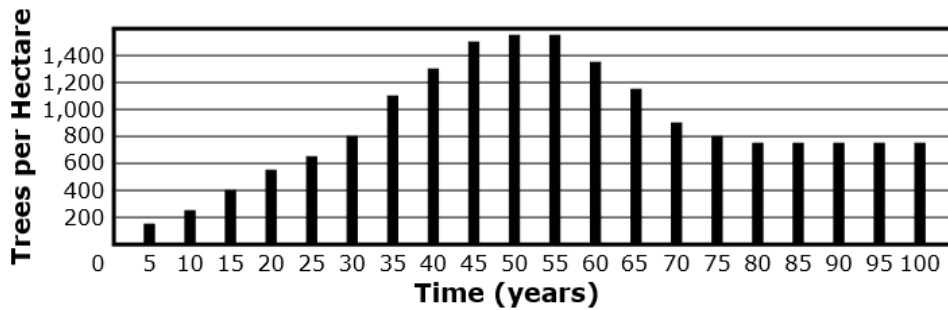
#### Part B: Plan B. (1 point)



Item	Grade	PE	SEP	DCI	CCC	DOK
22	High School	HS-LS2-2	5. Using Mathematics and Computational Thinking	LS2.A Interdependent Relationships in Ecosystems	3. Scale, Proportion, and Quantity	3

**ILCS:** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Students created a computer model of an ecosystem process to predict the density of different tree species in an area over 100 years. The graph shows the outcomes of the model for one of the tree species.



Complete the sentences by selecting from the menus. The process being modeled is **most likely**  following a disturbance. In years 75 to 100, the population can **best** be described as having reached .

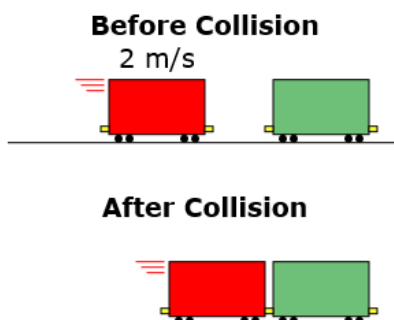
**Key:** First drop-down menu: ecological succession. Second drop-down menu: carrying capacity. (1 point)

## High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
23	High School	HS-PS2-2	5. Using Mathematics and Computational Thinking	PS2.A Forces and Motion	4. Systems and System Models	2

**ILCS:** Mathematically determine the properties of the system using the conservation of momentum of objects in the system.

A railroad car with a mass of 90,000 kg is traveling along a straight, horizontal track at a constant speed of 2 m/s. The car collides with a second railroad car, also with a mass of 90,000 kg, that is initially at rest. The railroad cars stick together after the collision, as shown in the figure.



What is the speed of the two railroad cars immediately after the collision?

- Ⓐ 0.5 m/s
- Ⓑ 1 m/s
- Ⓒ 2 m/s
- Ⓓ 4 m/s

**Key:** B (1 point)

Item	Grade	PE	SEP	DCI	CCC	DOK
24	High School	HS-ETS1-2	6. Constructing Explanations and Designing Solutions	ETS1.C Optimizing the Design Solution	N/A	4

**ILCS:** Match the described solutions to a provided list of broken-down criteria/constraints in order to reduce air pollution within the community.

In order to reduce air pollution, a particular community identifies three possible solutions. The community also proposes several criteria that the solutions must meet, including low cost and rapid impact. The three possible solutions are:

Solution 1: Begin phasing in renewable sources of electricity generation, which would involve building new types of power plants.

Solution 2: Encourage increased use of ride-sharing.

Solution 3: Encourage people to raise thermostat settings in the summer and lower them in the winter.

**Part A**

The community identified three constraints to help determine the best approach to reduce air pollution. For each of the three potential solutions, select the check box if the solution meets the constraint.

	Long time to implement change	Requires change in people’s behaviors	Provides benefits in a short time period
Solution 1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Solution 2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Solution 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Part B**

What additional information will be **most** helpful to the community to prioritize these approaches?

- Ⓐ the projected reduction in air pollution
- Ⓑ the projected cost savings of using renewable resources
- Ⓒ the number of homes projected to be built in the next 10 years
- Ⓓ the number of cars currently using electricity as an energy source

*Key follows on next page.*

**Key:**

**Part A:** (1 point)

	Long time to implement change	Requires change in people's behaviors	Provides benefits in a short time period
Solution 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Solution 2	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Solution 3	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**Part B:** A (1 point)

Item	Grade	PE	SEP	DCI	CCC	DOK
25	High School	HS-PS1-3	3. Planning and Carrying Out Investigations	PS1.A Structure and Properties of Matter	1. Patterns	2

**ILCS:** Identify the procedure that will produce the most relevant and reliable data in carrying out an investigation on attractive forces between particles.

**Part A**

A student is studying the attractive forces between particles within different substances. The student wants to determine the relative strengths of these forces for four solid substances: iodine, sulfur, tin, and zinc. What physical property of these substances would be **best** for the student to measure?

- Ⓐ density
- Ⓑ melting point
- Ⓒ solubility in water
- Ⓓ electrical conductivity

**Part B**

A physical property of a substance is often related to the strength of the attractions between the particles of the substance. In the table, identify whether each property is due to stronger or weaker attraction between particles in a substance.

	Due to stronger attractions between particles	Due to weaker attractions between particles
High boiling point	<input type="checkbox"/>	<input type="checkbox"/>
High vapor pressure	<input type="checkbox"/>	<input type="checkbox"/>

Key follows on next page.

## High School Practice Test Items

### Key:

**Part A:** B (1 point)

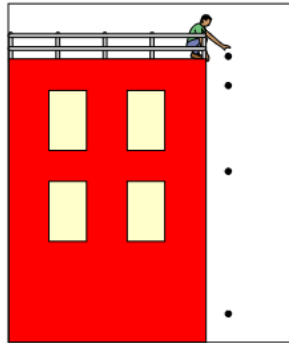
**Part B:** (1 point)

	Due to stronger attractions between particles	Due to weaker attractions between particles
High boiling point	<input checked="" type="checkbox"/>	<input type="checkbox"/>
High vapor pressure	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Item	Grade	PE	SEP	DCI	CCC	DOK
26	High School	HS-PS3-1	5. Using Mathematics and Computational Thinking	PS3.A Definitions of Energy	4. Systems and System Models	2

**ILCS:** Create a correct mathematical representation to determine the components of gravitational potential energy in the Earth-ball system and kinetic energy.

A student drops a tennis ball from the top of a building, as shown in the picture. Air resistance is negligible.



Explain how the student can determine the height of the building if the kinetic energy of the tennis ball is known when it hits the ground. In your explanation, use the terms kinetic energy, gravitational potential energy, acceleration due to gravity, mass, and height. Do not use equations. Enter your answer in the box provided.

B I U *I<sub>x</sub>*
☰ ☷ ☰ ☷
✂ 📄 📁 ⬅ ➡
ABC English Ω

**2 point**

**Exemplar:**

The kinetic energy (KE) of the ball at the bottom of the building is the same as the gravitational potential energy (GPE/PE) at the top of the building. The gravitational potential energy (GPE/PE) needs to be divided by the mass of the tennis ball and the acceleration due to gravity (or gravity) to find the height of the building.

*Rubric continues on the next page.*

**Rubric:**

The response says that the kinetic energy of the tennis ball at the bottom of the building is equal to the gravitational potential energy of the tennis ball at the top of the building. AND

The response says that the gravitational potential energy at the top of the building can be divided by the mass and acceleration due to gravity to find the height of the building.

**1 point****Exemplar:**

The kinetic energy (KE) of the ball at the bottom of the building is the same as the gravitational potential energy (GPE/PE) at the top of the building. OR

The gravitational potential energy (GPE/PE) needs to be divided by the mass of the tennis ball and the acceleration due to gravity (or gravity) to find the height of the building.

**Rubric:**

The response says that the kinetic energy of the tennis ball at the bottom of the building is equal to the gravitational potential energy of the tennis ball at the top of the building. OR

The response says that the gravitational potential energy at the top of the building can be divided by the mass and acceleration due to gravity to find the height of the building.

**0 point****Exemplar:**

The kinetic energy (KE) of the tennis ball at the bottom is not the same as the gravitational potential energy (GPE) of the ball at the top of the building. OR

Time how long it takes for the ball to fall to the ground. OR

Measure the height of the building with a meterstick.

**Rubric:**

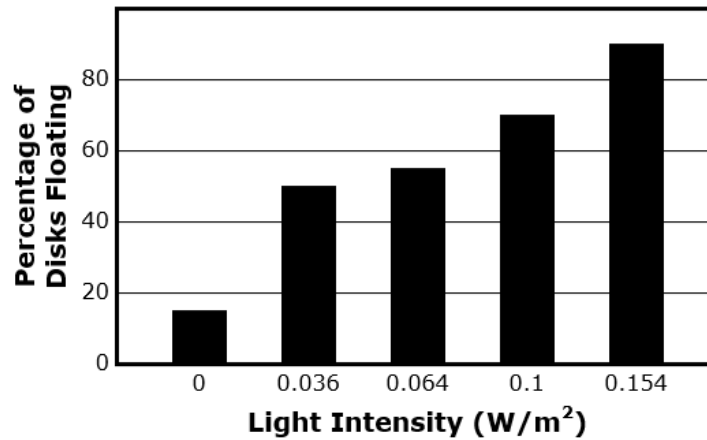
A 0-point response attempts to answer the prompt but is incorrect.



Item	Grade	PE	SEP	DCI	CCC	DOK
27	High School	HS-LS1-5	2. Developing and Using Models	LS1.C Organization for Matter and Energy Flow in Organisms	5. Energy and Matter	2

**ILCS:** Identify the mechanisms and relationships among the inputs and outputs of photosynthesis.

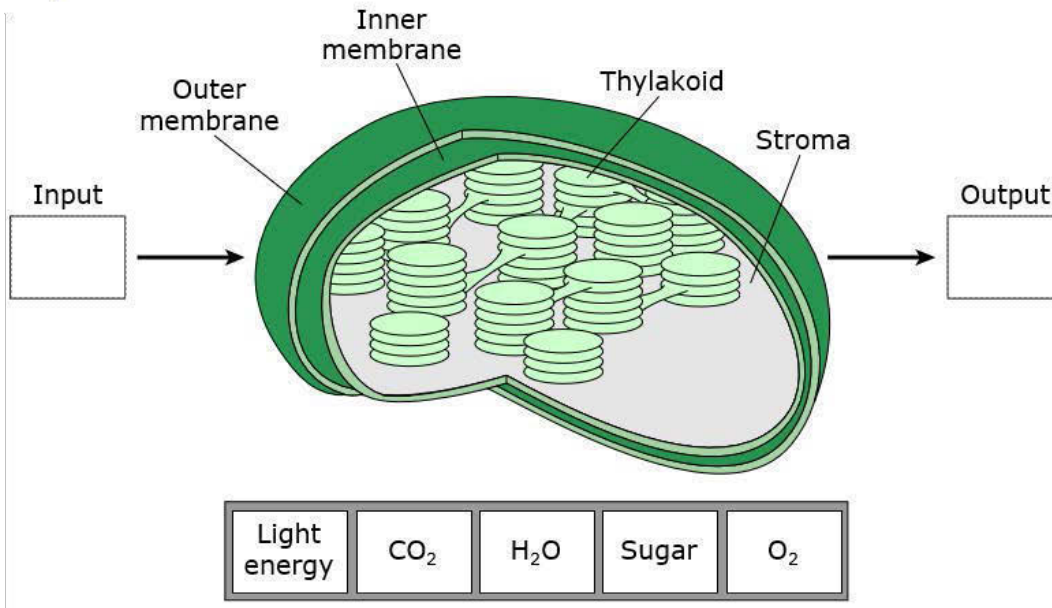
A student conducted an experiment to measure the effect of light on photosynthesis. The student placed small, disk-shaped pieces of fresh-cut leaves into several dishes with a bicarbonate solution and exposed each dish to a different intensity of light. The student observed bubbles and the number of leaf pieces that floated after 15 minutes of light exposure. The data are shown in the graph.



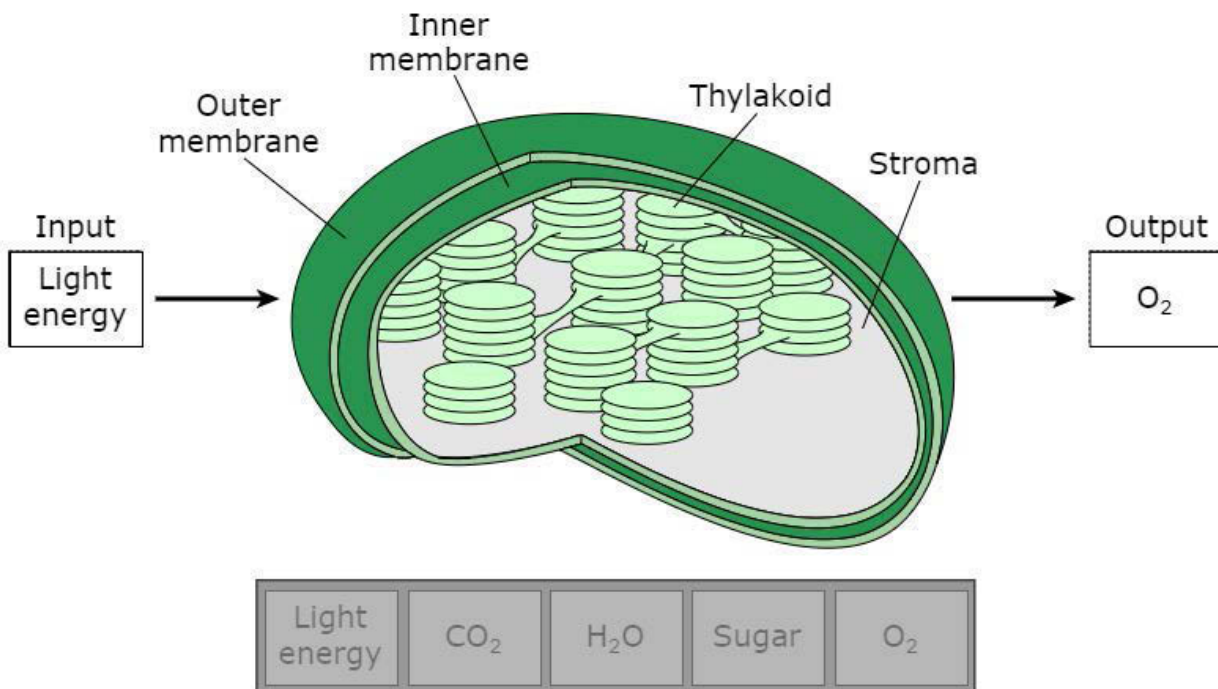
*Item continues on the next page.*

### High School Practice Test Items

Drag the input and output to the chloroplast that **best** represent the variables in the experiment.



**Key:** Input: Light energy. Output: O<sub>2</sub>. (1 point)



Item	Grade	PE	SEP	DCI	CCC	DOK
28	High School	HS-ESS1-6	6. Constructing Explanations and Designing Solutions	ESS1.C The History of Planet Earth	7. Stability and Change	2

**ILCS:** Identify the roles of various earth processes (e.g., plate tectonics and erosion) in the preservation and destruction of evidence about Earth history.

The Moon is thought to have formed shortly after the formation of Earth, and therefore the age of the Moon is comparable to that of Earth. The surface of the Moon is covered by ancient craters formed by impacts of small solar-system objects such as meteoroids, but the surface of Earth shows no such craters.

Which **two** statements are valid explanations for this observation?

- The Moon shielded Earth from impacts in the early solar system.
- Solar-system objects are more likely to impact satellites than planets.
- Geologic activity on Earth’s surface has destroyed evidence of impacts.
- The Moon has a very thin atmosphere, eliminating erosion due to weather.
- Earth’s atmosphere protected it from impacts by large solar-system objects.

**Key:** Third and fourth options. (1 point)

## High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
29	High School	HS-PS3-5	2. Developing and Using Models	PS3.C Relationship Between Energy and Forces	2. Cause and Effect	2

**ILCS:** Quantify the change in energy associated with the appropriate change in the relative orientation of the two objects.

Objects A and B, with opposite charges of  $+q$  and  $-q$ , respectively, are initially held in position at a fixed distance apart. Object B is then released and allowed to move relative to object A.

If gravitational forces are negligible, which statement describes what happens when object B is released?

- Ⓐ Object B moves toward object A, and the electric potential energy of the two charged objects increases.
- Ⓑ Object B moves toward object A, and the electric potential energy of the two charged objects decreases.
- Ⓒ Object B moves away from object A, and the electric potential energy of the two charged objects increases.
- Ⓓ Object B moves away from object A, and the electric potential energy of the two charged objects decreases.

**Key:** B (1 point)

Item	Grade	PE	SEP	DCI	CCC	DOK
30	High School	HS-LS2-7	6. Constructing Explanations and Designing Solutions	LS2.C Ecosystem Dynamics, Functioning, and Resilience	7. Stability and Change	2

**ILCS:** Evaluate and refine solutions based on achieving a balance between overall environmental stability and human needs based on the accidental introduction of invasive species.

Cargo ships that transport goods require ballast water to remain safe and stable during their voyage. These ships collect water from their port of origin and release that same water at the final destination. The ballast water often contains aquatic organisms that are present in the water at the port of origin. The release of ballast water can introduce invasive species into an ecosystem. A regulatory agency is investigating several methods to prevent this from happening. The agency is interested in identifying solutions that meet the following criteria:

- Ensure that organisms are removed from ballast water
- Have minimal impact on the environment
- Are cost effective
- Are easy to implement

Based on the agency’s criteria, select **three** methods that offer the **best** solution.

Method	Effectiveness in Removing Organisms	Environmental Impact	Ease of Implementation	Cost
Oxidizing chemical treatment	Effective	Very harmful to environment	Easy	High
Nonoxidizing chemical treatment	Effective	Some impact to environment	Easy	Average
Filtration	Very effective	Little impact to environment	Medium	Average
Thermal treatment	Effective	No impact to environment	Hard	Average
Alternative technologies	Not very effective	No impact to environment	Hard	Average

**Key:** Second, third, and fourth rows. (1 point)

## High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
31	High School	HS-PS2-3	6. Constructing Explanations and Designing Solutions	PS2.A Forces and Motion	2. Cause and Effect	3

**ILCS:** Select the design solution that best meets the provided criteria about momentum and force during a collision.

A student is asked to evaluate two different bumper designs that will be used on bumper cars at a local amusement park. The bumpers have the same mass and are each attached to a test car that undergoes a controlled collision with a wall. The student measures the average impact force on each bumper during the collision and the duration of each collision. The student's results are shown in the table.

Design Number	Average Impact Force (N)	Duration of Impact (s)
1	980	0.15
2	588	0.25

Which design will provide better protection for a rider in a collision, and why?

- Ⓐ Design 1, because the change in momentum of the test car is smaller.
- Ⓑ Design 1, because the average impact force acting on the test car is larger for a shorter duration.
- Ⓒ Design 2, because the change in momentum of the test car is smaller.
- Ⓓ Design 2, because the average impact force acting on the test car is smaller for a longer duration.

**Key:** D (1 point)

Item	Grade	PE	SEP	DCI	CCC	DOK
32	High School	HS-ESS1-2	6. Constructing Explanations and Designing Solutions	ESS1.A The Universe and Its Stars	5. Energy and Matter	3

**ILCS:** Explain the redshift pattern as indicating that more distant stars are moving away faster.





Scientists observe the light spectra from distant galaxies. The absorption lines in a spectrum from a galaxy moving away from Earth are observed to be shifted to longer wavelengths (redshift). The absorption lines from an approaching galaxy shift to shorter wavelengths (blueshift).

**Part A**

The diagram shows the spectra of three distant galaxies. Each spectrum shows the absorption lines from hydrogen. The pattern of absorption lines is the same for each galaxy, but the wavelengths of the lines are different.

The laboratory reference shows the wavelengths of the hydrogen absorption lines as measured on Earth.

Drag the correct label to each spectrum to identify whether the spectrum is redshifted, blueshifted, or not shifted.

	Laboratory reference
	<input type="text"/>
	<input type="text"/>
	<input type="text"/>

**Labels**

No shift

Blueshift

Redshift

*Item continues on the next page.*



## High School Practice Test Items




### Part B

Which **two** statements best explain how observations of the spectra of light from galaxies are used to support current theories of the origin and evolution of the Universe?

- Galaxies that are farther away tend to have larger redshifts.
- The blueshift observed from distant galaxies indicates that galaxies are colliding and forming new stars.
- The redshift observed from nearby galaxies indicates that most galaxies remain stationary relative to Earth.
- The blueshift observed from nearby galaxies indicates that the solar system is orbiting a black hole.
- The redshift observed from distant galaxies indicates that they are moving away faster than nearby galaxies.

#### Key:

**Part A:** From top to bottom: Redshift; Blueshift; No Shift. (1 point)

	Laboratory reference
	Redshift
	Blueshift
	No shift

#### Labels

No shift
Blueshift
Redshift

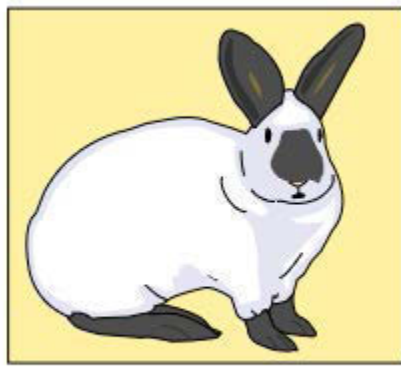
**Part B:** First and fifth options. (1 point)



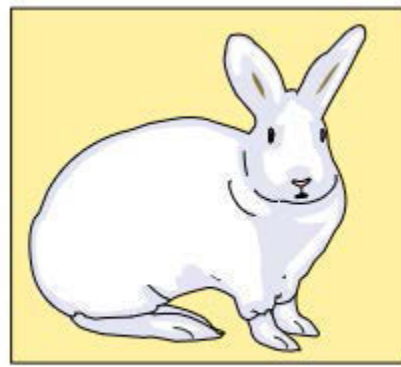
The following stimulus accompanies high school items 33 and 34 in the practice test.

In this performance task, you will answer six questions.

A family plans to purchase two Californian rabbits. Californian rabbits are white with black points (ears, nose, feet, and tail) and exhibit temperature-influenced color expression. The family finds a breeder who sells the two breeds of rabbits pictured, Californian and New Zealand.



Californian rabbit



New Zealand rabbit

The family purchases two eight-week-old Californian kits (baby rabbits) from this breeder. The family takes the kits home and places them outdoors (30°C) in a rabbit hutch. After a few weeks, both rabbits are white with gray points rather than black points. The family members wonder if they received the correct breed of rabbits.

The family starts to research the genetics of coat color in rabbits and learns that color expression in rabbit coats is primarily influenced by five different genes, all found on one chromosome. These five genes account for 144 different color variations found in rabbits.

In researching the genetics of Californian rabbit colors, the family learns that possible colors for the points include black and gray. The family then focuses its research on the *c* gene and *d* gene (dense-dilute gene).

This table summarizes the genetic patterns and phenotypes of the *c* gene and *d* gene.

### Inheritance Patterns of the *c* Gene and *d* Gene

<b>Gene</b>	<b>Allele</b>	<b>Inheritance Pattern</b>	<b>Expressed Phenotype</b>
<i>c</i> gene	$c^h$	Dominant	Himalayan (white body with colored points)
<i>c</i> gene	$c$	Recessive	White without points (albino)
<i>d</i> gene	$D$	Dominant	Black points (dense color)
<i>d</i> gene	$d$	Recessive	Gray points (dilute color)

Item	Grade	PE	SEP	DCI	CCC	DOK
33	High School	HS-LS3-2	7. Engaging in Argument from Evidence	LS3.B Variation of Traits	2. Cause and Effect	3

**ILCS:** Describe that crossing over is responsible for all of the variation in this rabbit species.

Based on this information, complete the sentence by selecting the **best** phrase from the menu.

is primarily responsible for the 144 different color variations found in rabbits.

**Key:** Drop-down menu: Crossing over during meiosis. (1 point)

## High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
34	High School	HS-LS3-1	1. Asking Questions and Defining Problems	LS3.A Inheritance of Traits	2. Cause and Effect	3

**ILCS:** Select the question that challenges the argument about phenotype and genotype connections in this rabbit species.

Which scientifically correct question **best** challenges the family member's argument?

- Ⓐ Do the rabbits have the correct number of chromosomes and corresponding genes?
- Ⓑ Does biological sex have any influence on the expression of the rabbits' *c* gene?
- Ⓒ Do the rabbits have a phenotype (albino) consistent with the *cc* genotype?
- Ⓓ Does having the *cc* genotype affect the color of the rabbits' coats?

**Key:** C (1 point)

The following stimulus accompanies high school items 35 and 36 in the practice test.

In anticipation of a heat wave, the family members move the rabbits from their outdoor hutch (30°C) to an air-conditioned room (20°C) inside their home.

Several days after the rabbits were moved, their gray points turned black. The family decides to take the rabbits to a veterinarian who treats and also breeds Californian rabbits.

Refer to this table for genetic information about the *c* gene and *d* gene.

### Inheritance Patterns of the *c* Gene and *d* Gene

Gene	Allele	Inheritance Pattern	Expressed Phenotype
<i>c</i> gene	$c^h$	Dominant	Himalayan (white body with colored points)
<i>c</i> gene	$c$	Recessive	White without points (albino)
<i>d</i> gene	$D$	Dominant	Black points (dense color)
<i>d</i> gene	$d$	Recessive	Gray points (dilute color)

The family finds an online simulation that allows them to observe how temperature affects the rabbits' point color, assuming that the rabbits have at least one copy of the Himalayan allele ( $c^h$ ). Depending on the air temperature, the  $c^h$  allele controls point color expression by interacting with the *d* gene.

This table shows the simulation results for expressed point color in rabbits with the  $c^h$  allele.

### Simulation Results

<b>Temperature</b>	<b><i>DD</i></b>	<b><i>Dd</i></b>	<b><i>dd</i></b>
20°C	Black pointed	Black pointed	Gray pointed
30°C	Gray pointed	Gray pointed	Gray pointed

Item	Grade	PE	SEP	DCI	CCC	DOK
35	High School	HS-LS3-1	1. Asking Questions and Defining Problems	LS3.A Inheritance of Traits	2. Cause and Effect	3

**ILCS:** Select questions that address the relationship between a chromosome and gene expression in this rabbit species.

Which **three** questions should the family ask their veterinarian that would **most likely** help the family understand the genetic basis for the recent color change of the rabbits?

- Is it possible for these rabbits to be heterozygous for the  $c$  gene, since the rabbits seem to express the Himalayan allele ( $c^h$ )?
- Is it possible for these rabbits to be heterozygous for the  $d$  gene, since they now have black points rather than gray points?
- Is it possible that the rabbits have eaten an unfamiliar food that has caused a change to their genetic make-up?
- Is it possible that the rabbits have contracted a parasite and this is affecting the expression of the  $c$  gene?
- Is it possible that the lower temperature of the room had an effect on the expression of the  $c$  gene?

**Key:** First, second, and fifth options. (1 point)

## High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
36	High School	HS-LS3-2	7. Engaging in Argument from Evidence	LS3.B Variation of Traits	2. Cause and Effect	3

**ILCS:** Describe how the environmental conditions will impact the expression of the trait in this rabbit species.

Based on the simulation results and assuming that the rabbits inherited at least one Himalayan allele ( $c^h$ ), select the words from the menus that **best** complete the sentence.

Temperatures 30°C and higher will act on the  of Californian rabbits and cause the expression of the  phenotype even if the rabbits inherited a dominant allele for the gene.

**Key:** First drop-down menu: color gene. Second drop-down menu: gray-pointed. (1 point)



The following stimulus accompanies high school items 37 and 38 in the practice test.

The two rabbits eventually mate and the female gives birth to six kits. The kits are being raised in a 20°C room. One kit is albino and five are black pointed.

A family member suggests using this Punnett square to model the inheritance of the *d* gene for the newborn kits.

	<i>D</i>	<i>d</i>
<i>d</i>	<i>Dd</i>	<i>dd</i>
<i>d</i>	<i>Dd</i>	<i>dd</i>

Refer to these tables for genetic and environmental information about the *c* gene and *d* gene.

### Inheritance Patterns of the *c* Gene and *d* Gene

Gene	Allele	Inheritance Pattern	Expressed Phenotype
<i>c</i> gene	<i>c<sup>h</sup></i>	Dominant	Himalayan (white body with colored points)
<i>c</i> gene	<i>c</i>	Recessive	White without points (albino)
<i>d</i> gene	<i>D</i>	Dominant	Black points (dense color)
<i>d</i> gene	<i>d</i>	Recessive	Gray points (dilute color)

### Simulation Results

<b>Temperature</b>	<b><i>DD</i></b>	<b><i>Dd</i></b>	<b><i>dd</i></b>
20°C	Black pointed	Black pointed	Gray pointed
30°C	Gray pointed	Gray pointed	Gray pointed

Item	Grade	PE	SEP	DCI	CCC	DOK
37	High School	HS-LS3-1	1. Asking Questions and Defining Problems	LS3.A Inheritance of Traits	2. Cause and Effect	3

**ILCS:** Select a scientifically correct question that challenges the conclusions about the offspring phenotypes in this rabbit species.

Which scientifically correct question would **best** challenge the conclusions made about the kits' genotypes from the suggested Punnett square?

- Ⓐ Why is only one kit albino?
- Ⓑ Why do only some of the kits have black points?
- Ⓒ What are the genotypes of the two parent rabbits for the *d* gene?
- Ⓓ Can you make a prediction of point color without knowing the genotype of the *c* gene?

**Key:** C (1 point)

Item	Grade	PE	SEP	DCI	CCC	DOK
38	High School	HS-LS3-2	7. Engaging in Argument from Evidence	LS3.B Variation of Traits	2. Cause and Effect	4

**ILCS:** Explain that genetic variation depends on both environmental and genetic factors in this rabbit species.

Based on the information in the tables, explain how **both** genetic and environmental factors can affect point color variation in Californian rabbits. Enter your answer in the box provided.



**2 point**

**Exemplar:**

Genetic factors can affect point color variation because the color/phenotype expressed/shown depends partly on the alleles that are inherited. Environmental factors can affect point color variation because the temperature that the rabbit is exposed to/lives in, will influence/control the expression of its inherited alleles, altering/changing its phenotype/point color.

**Rubric:**

The response indicates that genetic factors affect point color variation because the specific phenotype expressed (black or gray) depends partly on the alleles that are inherited. AND

The response indicates that environmental factors can affect point color variation because the temperature that the rabbit is exposed to will influence the expression of its inherited alleles, thus altering its phenotype.

**1 point**

**Exemplar:**

Genes can affect the color because the color/phenotype expressed/shown depends partly on the alleles that are inherited. OR

The environment affects the color of the rabbit because the temperature that the rabbit lives in can make its color change. OR

The temperature change caused the rabbit's points to change color. OR

The rabbit's genes and the environment both affect the point color.

**Rubric:**

The response only indicates that genetic factors affect point color variation because the specific phenotype expressed (black or gray) depends partly on the alleles that are inherited. OR

The response only indicates that environmental factors can affect point color variation because the temperature that the rabbit is exposed to will influence the expression of its inherited alleles, thus altering its phenotype. OR

The response only indicates that a relationship exists between the rabbit's genes and the environment but does not provide any reasoning.

**0 point**

**Exemplar:**

Neither genes nor environment affect point color variation. OR

The rabbit's genes affect point color variation more than the environment. OR

The environment affects point color variation more than the rabbit's genes. OR

Only the rabbit's genes affect point color variation. OR

Only the environment affects point color variation.

**Rubric:**

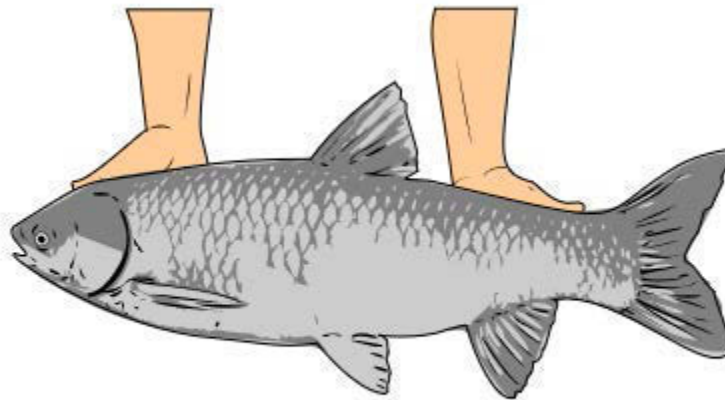
A 0-point response attempts to answer the prompt but is incorrect.

The following stimulus accompanies high school items 39 and 40 in the practice test.

In this performance task, you will answer six questions.

Silver carp are an invasive species of fish that is not native to the United States. However, populations of silver carp now inhabit the rivers of the United States and can be found throughout the Mississippi River system.

Silver carp feed on phytoplankton, including algae, consuming up to 20% of their body weight daily. Carp can lay hundreds of thousands of eggs at a time, several times a year. They are capable of jumping over barriers, including low dams, and can travel to new areas when flooding connects previously unconnected bodies of water. This picture shows a silver carp.



Silver carp

Item	Grade	PE	SEP	DCI	CCC	DOK
39	High School	HS-ESS3-1	6. Constructing Explanations and Designing Solutions	ESS3.B Natural Hazards	2. Cause and Effect	3

**ILCS:** Use the data as evidence to support an explanation about an environmental problem involving this fish species.

Silver carp were intentionally introduced by humans to solve an environmental problem. Which claim is **best** supported by this information?

- Ⓐ Silver carp were placed in fish farms to control the growth of algae.
- Ⓑ Silver carp were used to introduce new genes into the native fish populations.
- Ⓒ Silver carp were introduced to improve the natural beauty of the aquatic landscape.
- Ⓓ Silver carp were introduced to help increase rates of photosynthesis because they support algae populations.

**Key:** A (1 point)

High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
40	High School	HS-ESS3-1	6. Constructing Explanations and Designing Solutions	ESS3.A Natural Resources	2. Cause and Effect	3

**ILCS:** Use the data as evidence to support an explanation about an environmental problem concerning this fish species.

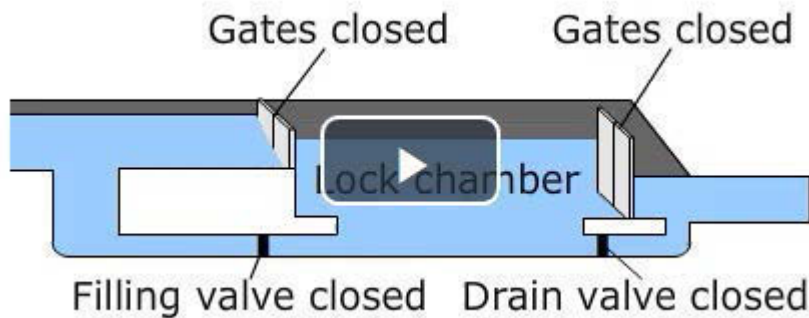
Complete this sentence by selecting the **best** phrase from the menu.

Silver carp in the Mississippi River are considered an invasive species and have altered the ecosystem of the river because they

**Key:** Drop-down menu: outcompete native fish species for food. (1 point)



The following stimulus accompanies high school items 41 and 42 in the practice test.



An additional method to stop the movement of silver carp into the Great Lakes would be to construct steel cables attached to the bottom of the canal. The cables would create a pulsating field of electricity that would discourage fish from passing through the barrier.

This map shows the location of the electric barriers and the lock and dams of the Chicago Area Waterway System.



High School Practice Test Items

This map shows the locations of the Mississippi River, Lake Michigan, and the canal system.



Item	Grade	PE	SEP	DCI	CCC	DOK
41	High School	HS-ESS3-4	6. Constructing Explanations and Designing Solutions	ESS3.C Human Impacts on Earth Systems	7. Stability and Change	3

**ILCS:** Provide justification for a design solution to mitigate the effects of an environmental problem as a result of this fish species.

Which **two** are the **most likely** reasons that the electric barriers are needed in addition to locks and dams to control the movement of silver carp?

- Silver carp are attracted to dams.
- The dams cannot prevent the movement of silver carp.
- When ships move through the locks, the silver carp can follow them.
- The electric barriers use renewable energy, while the locks are powered by fossil fuels.

**Key:** Second and third options. (1 point)

Item	Grade	PE	SEP	DCI	CCC	DOK
42	High School	HS-ESS3-4	6. Constructing Explanations and Designing Solutions	ESS3.C Human Impacts on Earth Systems	7. Stability and Change	3

**ILCS:** Identify potential concerns from a proposed design solution for an environmental problem caused by restricting fish territory.

Although the electrical barrier acts to repel the silver carp, it is not perfect. Which statement **best** describes a disadvantage of the electric barrier solution?

- Ⓐ The barrier is powered by renewable energy sources.
- Ⓑ The barrier is too far from Lake Michigan to be effective in controlling silver carp populations.
- Ⓒ Silver carp are not killed by the electricity; therefore, they might still get past the barrier and move into Lake Michigan.
- Ⓓ All fish in the area will be prevented from moving past the barrier; therefore, eventually no fish will be found in Lake Michigan.

**Key:** C (1 point)

The following stimulus accompanies high school items 43 and 44 in the practice test.

Recreational fishing is very popular in the Great Lakes, due to the many native species of desirable fish. It also provides billions of dollars and tens of thousands of jobs to the region. Silver carp are not considered desirable for recreational fishing; if they entered the Great Lakes, they would replace the native fish. This table summarizes the recreational fishing income from the Great Lakes.

**Income from Great Lakes Fishing Activity in Selected States and All States Combined**

<b>State</b>	<b>Jobs</b>	<b>Income Received</b>
Illinois	1,500	\$175,000,000
Indiana	4,200	\$395,000,000
Michigan	8,300	\$1,002,000,000
New York	3,300	\$369,000,000
Ohio	9,900	\$809,000,000
All States	58,000	\$7,000,000,000

Local stakeholders claim that investing \$228 million of federal funds to block silver carp from entering the Great Lakes would be beneficial for this region’s economy.

## High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
43	High School	HS-ESS3-1	6. Constructing Explanations and Designing Solutions	ESS3.B Natural Hazards	2. Cause and Effect	2

**ILCS:** Identify aspects of the data that align to the claim about the effects of an environmental problem caused by the introduction of a new species.

Based on the data table, which **two** states would be **most** affected from the introduction of silver carp into the Great Lakes?

- Illinois
- Indiana
- Michigan
- New York
- Ohio

**Key:** Third and fifth options. (1 point)

Item	Grade	PE	SEP	DCI	CCC	DOK
44	High School	HS-ESS3-4	6. Constructing Explanations and Designing Solutions	ESS3.C Human Impacts on Earth Systems	7. Stability and Change	3

**ILCS:** Identify (with reasoning) whether the data is sufficient to support the claim about this invasive fish species.

Use **two** pieces of evidence to support the investment of \$228 million to block silver carp from entering the Great Lakes. Explain why the evidence supports such an investment. Enter your answer in the box provided.

B I U I<sub>x</sub>
☰ ☰ ☰ ☰
✂ 📄 📄 ↶ ↷
ABC English Ω

**2 point**

**Exemplar:**

Response should include any TWO of the following:

The Great Lakes/fishing industry makes/generates/brings in \$7 billion per year so it would only take one year to recoup/get back the \$228 million investment.

The silver carp would greatly reduce the fishing revenue/income because the economy is dependent on the fishing industry.

The silver carp would reduce/lower the number of jobs because the economy is dependent on the fishing industry.

If the silver carp were to enter/be introduced into the lakes, they would replace the native fish species, negatively disrupting/harming the ecosystem.

*Rubric continues on the next page.*

**Rubric:**

A 2-point response indicates any TWO of the following:

The fishing industry of the Great Lakes generates \$7 billion in revenue per year so it would only take one year to recoup the \$228 million investment.

The introduction of the silver carp would lower incoming revenue because the economy of the Great Lakes is heavily dependent on the fishing industry.

The introduction of the silver carp would reduce available jobs because the economy of the Great Lakes is heavily dependent on the fishing industry.

The introduction of the silver carp would disrupt the ecosystem by replacing native fish species.

**1 point**

**Exemplar:**

The Great Lakes/fishing industry makes/generates/brings in \$7 billion per year so it would only take one year to get back the \$228 million investment. OR

The silver carp would greatly reduce the fishing revenue/income because the economy is dependent on the fishing industry. OR

The silver carp would reduce/lower the number of jobs because the economy is dependent on the fishing industry. OR

If the silver carp were to enter/be introduced into the lakes, they would replace the native fish species, negatively disrupting/harming the ecosystem.

**Rubric:**

The fishing industry of the Great Lakes generates \$7 billion in revenue per year so it would only take one year to recoup the \$228 million investment. OR

The introduction of the silver carp would lower incoming revenue because the economy of the Great Lakes is heavily dependent on the fishing industry. OR

The introduction of the silver carp would reduce available jobs because the economy of the Great Lakes is heavily dependent on the fishing industry. OR

The introduction of the silver carp would disrupt the ecosystem by replacing native fish species.

*Rubric continues on the next page.*



**0 point**

**Exemplar:**

Great Lakes fishermen can fish for the silver carp. OR

The government should not invest \$228 million. OR

The evidence shows that the government should make the investment. OR

The ecosystem would not be affected by the silver carp.

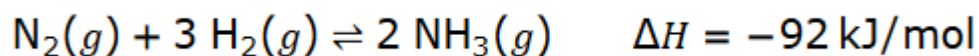
**Rubric:**

A 0-point response attempts to answer the prompt but is incorrect.

The following stimulus accompanies high school item 45 in the practice test.

In this performance task, you will answer seven questions.

Ammonia ( $\text{NH}_3$ ) gas is needed to manufacture fertilizers.  $\text{NH}_3$  is produced through an equilibrium reaction between nitrogen ( $\text{N}_2$ ) and hydrogen ( $\text{H}_2$ ) gases. At equilibrium, the rate of the forward reaction is equal to the rate of the reverse reaction. This is the chemical equation for the production of  $\text{NH}_3$ , including the heat of reaction,  $\Delta H$ .



A fertilizer manufacturer wants to increase profits by shifting the reaction to the right in order to maximize the amount of  $\text{NH}_3$  produced. The manufacturer hires a chemical engineer to improve the production processes and increase  $\text{NH}_3$  yields.

To start researching ways for improvement, the engineer considers Le Chatelier's principle, which can be explained by this statement: "If a change in conditions causes a stress to a system at equilibrium, the system readjusts to restore the system to equilibrium."

Item	Grade	PE	SEP	DCI	CCC	DOK
45	High School	HS-PS1-6	6. Constructing Explanations and Designing Solutions	PS1.B Chemical Reactions	7. Stability and Change	3

**ILCS:** Identify the scientific principles that support the effectiveness of the changes to meet the criteria required by the engineer in manufacturing fertilizer.

Based on this information, what **two** changes to the system at equilibrium should the engineer suggest in order to increase the amount of  $\text{NH}_3$  produced?

- Remove  $\text{NH}_3$  from the reaction chamber as it is produced.
- Decrease the temperature of the reaction chamber.
- Increase the temperature of the reaction chamber.
- Remove  $\text{H}_2$  from the reaction chamber.
- Remove  $\text{N}_2$  from the reaction chamber.

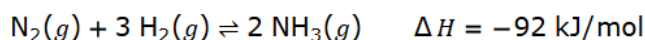
**Key:** First and second options. (1 point)

## High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
46	High School	HS-PS1-7	5. Using Mathematics and Computational Thinking	PS1.B Chemical Reactions	5. Energy and Matter	3

**ILCS:** Select the mathematical representation that predicts the mass of the other component based on a chemical reaction.

This is the chemical reaction for the production of  $\text{NH}_3$ .



The manufacturer explains to the engineer that the minimum production of  $\text{NH}_3$  should be 102 g at equilibrium.

This table shows the molar mass for each substance in the equilibrium reaction.

Molecule	Molar Mass (g/mol)
$\text{N}_2$	28
$\text{H}_2$	2
$\text{NH}_3$	17



Based on this information, select the correct number of grams for each reactant from the menus.

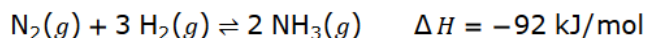
If 102 g of  $\text{NH}_3$  were produced, at least  g of  $\text{N}_2$  and at least  g of  $\text{H}_2$  would have been consumed during the reaction.

**Key:** First drop-down menu: 84. Second drop-down menu: 18. (1 point)

Item	Grade	PE	SEP	DCI	CCC	DOK
47	High School	HS-PS1-7	5. Using Mathematics and Computational Thinking	PS1.B Chemical Reactions	5. Energy and Matter	3

**ILCS:** Select the mathematical relationships that best demonstrate that atoms are conserved in the chemical reaction.

This is the chemical reaction for the production of  $\text{NH}_3$ .



The manufacturer explains to the engineer that the minimum production of  $\text{NH}_3$  should be 102 g at equilibrium.

This table shows the molar mass for each substance in the equilibrium reaction.

Molecule	Molar Mass (g/mol)
$\text{N}_2$	28
$\text{H}_2$	2
$\text{NH}_3$	17



If 4 moles of  $\text{N}_2$  and 12 moles of  $\text{H}_2$  were consumed in the production of  $\text{NH}_3$ , how many moles of ammonia were produced?

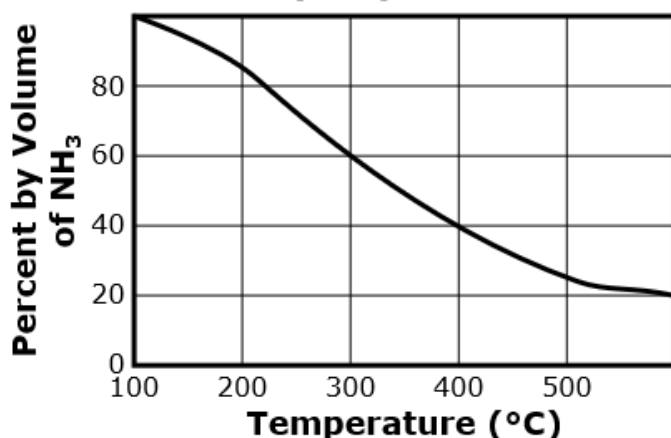
- (A) 6 moles
- (B) 8 moles
- (C) 16 moles
- (D) 32 moles

**Key:** B (1 point)

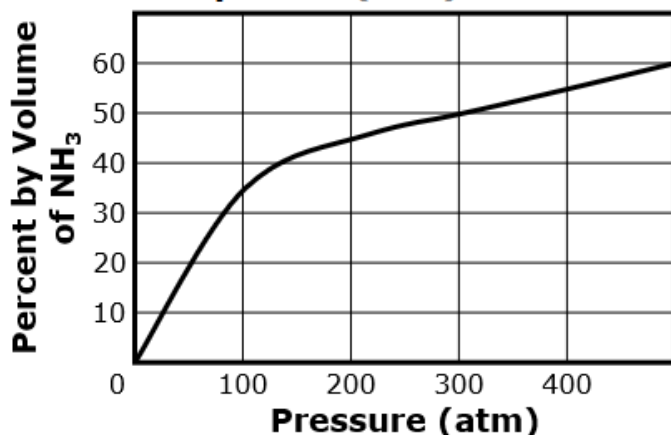
The following stimulus accompanies high school items 48 through 51 in the practice test.

The engineer suggests changing the temperature and pressure of the reaction chamber to increase the amount of  $\text{NH}_3$  at equilibrium. The engineer shares data on alternative temperatures, pressures, and percent by volume of  $\text{NH}_3$  at equilibrium, as shown on these graphs.

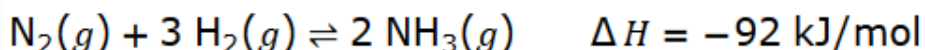
**Percent by Volume of ( $\text{NH}_3$ ) vs.  
Temperature ( $^\circ\text{C}$ ) at 200 Atmospheres  
(atm)**



**Percent by Volume of ( $\text{NH}_3$ ) vs. Pressure  
in Atmospheres (atm) at  $400^\circ\text{C}$**



This is the chemical reaction for the production of  $\text{NH}_3$ .



Item	Grade	PE	SEP	DCI	CCC	DOK
48	High School	HS-PS1-6	6. Constructing Explanations and Designing Solutions	PS1.B Chemical Reactions	7. Stability and Change	3

**ILCS:** Select the change that best meets the criteria and justifies the change in temperature necessary for increasing the amount of fertilizer manufactured.

Based on these data, complete the sentences by selecting the **best** word or phrase from the menus.

To increase the amount of  $\text{NH}_3$  at equilibrium at 200 atm, the manufacturer should  the temperature of the reaction chamber. This change in temperature would shift the reaction to the  because this equilibrium reaction is .

**Key:** First drop-down menu: decrease. Second drop-down menu: right. Third drop-down menu: exothermic. (1 point)

## High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
49	High School	HS-PS1-6	6. Constructing Explanations and Designing Solutions	PS1.B Chemical Reactions	7. Stability and Change	3

**ILCS:** Identify the advantages and disadvantages for each change in fertilizer production.

Using the information in **both** graphs, select the check boxes to indicate whether each description is an advantage or a disadvantage for the overall production of fertilizer.

	Advantage	Disadvantage
Reduced reaction rates at low temperatures	<input type="checkbox"/>	<input type="checkbox"/>
High purchase and maintenance costs for high pressure machines	<input type="checkbox"/>	<input type="checkbox"/>
Pressures higher than 200 atm at 400°C produce more than a 45% yield of NH <sub>3</sub> at equilibrium	<input type="checkbox"/>	<input type="checkbox"/>
Temperatures lower than 400°C at 200 atm produce more than a 40% yield of NH <sub>3</sub> at equilibrium	<input type="checkbox"/>	<input type="checkbox"/>

Key follows on the next page.



**Key:** (1 point)

	<b>Advantage</b>	<b>Disadvantage</b>
Reduced reaction rates at low temperatures	<input type="checkbox"/>	<input checked="" type="checkbox"/>
High purchase and maintenance costs for high pressure machines	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Pressures higher than 200 atm at 400°C produce more than a 45% yield of NH <sub>3</sub> at equilibrium	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Temperatures lower than 400°C at 200 atm produce more than a 40% yield of NH <sub>3</sub> at equilibrium	<input checked="" type="checkbox"/>	<input type="checkbox"/>

## High School Practice Test Items

Item	Grade	PE	SEP	DCI	CCC	DOK
50	High School	HS-PS1-6	6. Constructing Explanations and Designing Solutions	PS1.B Chemical Reactions	7. Stability and Change	2

**ILCS:** Identify the change to the system that will meet the criteria to maintain equilibrium.

Based on these data, what pressure would produce the **highest** amount of  $\text{NH}_3$  at equilibrium at  $400^\circ\text{C}$ ?

- Ⓐ 100 atm
- Ⓑ 200 atm
- Ⓒ 300 atm
- Ⓓ 400 atm

<b>Key:</b> D (1 point)
-------------------------

Item	Grade	PE	SEP	DCI	CCC	DOK
51	High School	HS-PS1-6	6. Constructing Explanations and Designing Solutions	PS1.B Chemical Reactions	7. Stability and Change	3

**ILCS:** Identify or describe the scientific principles that support the effectiveness of the change to meet the criteria to maintain equilibrium.

Using Le Chatelier’s principle, explain how an increase in pressure in the system at a constant temperature and volume would also disrupt the equilibrium and increase the amount of  $\text{NH}_3$  when equilibrium is restored. Enter your answer in the box provided.

**B** *I* U ~~I<sub>x</sub>~~
☰ ☰ ☰ ☰
✂ 📄 📄 ↶ ↷
ABC English Ω

**2 point**

**Exemplar:**

An increase in pressure would increase the frequency/number of collisions between molecules/reactants. The reaction will reduce the effect of this by shifting the equilibrium to the right and producing more ammonia/ $\text{NH}_3$  because there are fewer molecules on the right side/with the products of the equation.

**Rubric:**

The response should indicate that an increase in pressure would increase the frequency of collisions between the reactant molecules. AND

The response should indicate that the equilibrium reactions want to reduce the effects of any changes, so the equilibrium will shift to the right, producing more ammonia to reduce the overall pressure of the system.

*Rubric continues on the next page.*

**1 point****Exemplar:**

An increase in pressure would increase the frequency/number of collisions between molecules/reactants. OR

The reaction will adjust for/compensate for/reduce effects of the increase in pressure by shifting the equilibrium to the right and producing more ammonia/ $\text{NH}_3$ . OR

The equilibrium will shift/move to the right, producing more ammonia/ $\text{NH}_3$ .

**Rubric:**

The response should indicate that an increase in pressure would increase the frequency of collisions between the reactant molecules. OR

The response should indicate that the equilibrium reactions want to reduce the effects of any changes, so the equilibrium will shift to the right producing more ammonia to reduce the overall pressure of the system.

**0 point****Exemplar:**

The percent yield of ammonia or  $\text{NH}_3$  at equilibrium would not be affected by an increase in pressure. OR

An increase in pressure would decrease the frequency/number of collisions between molecules/reactants. OR

The equilibrium will shift to the left, producing less ammonia/ $\text{NH}_3$ .

**Rubric:**

A 0-point response attempts to answer the prompt but is incorrect.