NJSLA-S

New Jersey Student Learning
Assessment for Science

Instructional Guide

Constructed Response Questions

Computer-Based & Paper-Based Testing
Science

STATE OF NEW JERSEY
DEPARTMENT OF EDUCATION

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New Jersey Student Learning Assessment–Science
(NJSLA–S)
Grades 5, 8, 11

Instructional Guide
Constructed Response Questions

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Overview of the New Jersey Student Learning Assessment–Science

In the Spring of 2019, New Jersey replaced the New Jersey Assessment of Skills and Knowledge (NJ ASK) with the New Jersey Student Learning Assessment–Science (NJSLA–S), one component of a larger system of state assessments. Along with other indicators of student progress, the results of these elementary, middle and high school assessments are intended to provide meaningful information that complements the various measures of student performance used by districts. The main goal of the assessment is to determine the proficiency level of students in both the required knowledge of their grade band, and their ability to utilize the science and engineering practices to explain appropriate phenomena.

Federal requirement through the Every Student Succeeds Act (ESSA) and New Jersey Administrative Code 6A:8–4.1 requires assessment in science at least once in Elementary school (grades 3–5), Middle school (grades 6–9), and High school (grades 10–12).

All New Jersey fifth-, eighth- and eleventh-grade students took the New Jersey Student Learning Assessment–Science for the first time in April 2018. Since the New Jersey SLA–S was a field test in 2018, the first operational assessment occurred in the spring of 2019.

NJSLA–Science and Constructed Response Questions

The main goal of the assessment is to determine the proficiency level of students in both the required knowledge of their grade band and their ability to utilize the science and engineering practices to explain appropriate phenomena. The NJSLA–S is not intended to be a formative indicator for the individual student—the focus is on overall proficiency.

The NJSLA–S consists of four units with two sections: machine scorable and performance based. The performance-based section contains a constructed response item scored on a 0–4 point rubric. Students will type a response in a text box to answer the question or questions. Given the great variability in expected responses, these items are human scored. Each item includes an item-specific scoring rubric. All performance-based sections consist of between 2 and 4 technology-enhanced items and one constructed response item. Each item is aligned to one (1) Disciplinary Core Idea (DCI), one (1) Science and Engineering Practice (SEP), and one (1) Crosscutting Concept (CCC).

The NJSLA–S consists of questions-related standards that are spread out over the grade band. It measures a student's ability to solve problems by applying science concepts. The Disciplinary Core Ideas of Earth and Space, Life, and Physical Science will be reported, as well as the Science and Engineering Practices of Investigating, Sensemaking, and Critiquing. Not all standards of a grade band will appear every year of the assessment, but all will be eligible to select from when developing the assessment. The NJSLA–S is not specifically designed to follow a single course but rather an entire grade band. Participation in the NJSLA–S is not determined by course enrollment, but instead by grade-level enrollment as shown previously.

Description of this Manual

This manual contains three constructed-response items, one from each tested grade (5, 8, 11). Included for each item are the question itself, an item-specific scoring guide, and three exemplar responses from each score point.

Samples are included for each score point (all of these items use a 4-point scale). The sample responses, which are grouped by score point, represent a range of approaches that a fifth, eighth, or eleventh-grade science student could take with this constructed-response item. Each response is annotated according to the criteria in the scoring guide for that item, to indicate why the response received the score it did.

The responses selected to appear in this handbook were written by fifth, eighth, and eleventh-grade students. The responses appear as the students wrote them; no corrections have been made other than the deletion of specific names that may have appeared to identify the student or the student's school district.

NJSLA–S Grade 5
Rubric/Sample Responses
Chameleons

Some animals have a very long, sticky tongue.

Scientists conduct an investigation of the chameleon and the beetles shown in the video.

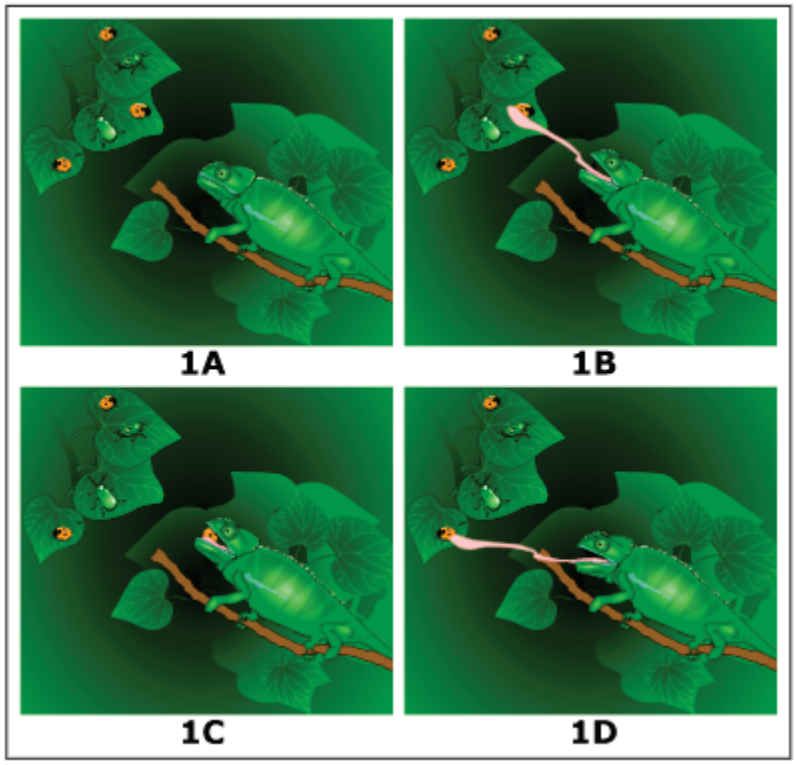

Figure 1. Chameleon Eating Beetles

Based on the video, describe **four** ways that external or internal parts of the chameleon help it survive.

Enter your answer in the box. Support your answer with information from the video.

(Student response goes here)

Note: Students who answered this item online were able to watch a video. Figure 1 was used by students who took the pencil-paper test.

Content alignment

Domain:
Life Science

SEP Reporting Category:
Sensemaking

Phenomenon:
Some animals have a very long, sticky tongue.

NJSLA Standard:

4-LS1 From Molecules to Organisms: Structures and Processes

4-LS1-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. [Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.] [Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems.]

SEP (Science and Engineering Practices):

CEDS Constructing explanations (for science) and designing solutions (for engineering)

DCI (Disciplinary Core Ideas):

LS1.A Structure and Function

CCC (Crosscutting Concepts):

SF Structure and Function

This item has 4 quality points:

- 1 point for each of four ways that the external or internal parts of the chameleon help it to survive.

4 quality points = a score of 4

3 quality points = a score of 3

2 quality points = a score of 2

1 quality point = a score of 1

0 quality points = a score of 0

Student response #1:

Four ways that the external or internal parts of a chameleon survive are **Number 1:** a chameleons long toung helps it reach food that is longer away and the stickiness helps it hold the bugs so they won't fly away. **Number 2;** a chameleons skin helps it camouflage and blend in into it's surroundings so it won't get eaten. **Number 3:** A Chameleons eyes help it see it's prey and help it see the predators around it. **Number 4:** A chameleons arms and legs and help it grab on to a branch and help the chameleon not fall off of the branch. One more fact about a chameleon is that it's tail helps it grab on to things and it also helps the chameleon balance on a small tree branch, a large tree branch. Or it helps it balance climbing up a very tall large tree, or a very tall small tree. Those are four ways that the external parts or the internal parts help a chameleon survive in the wild.

Score Points: 4

Scoring note:

The student has correctly described more than four ways that the parts of the chameleon help it survive [*long tongue helps it reach food, sticky tongue helps it hold bugs, skin helps it camouflage so it won't get eaten, eyes help it see its predators and prey, arms and legs help it grab onto a branch so it doesn't fall off, tail helps it balance*]. Note that any four of these answers would have been sufficient for full credit.

Student response #2:

The four ways that the external or internal part of the chameleon help it survive. In the video the chameleon was green it blended in with its surroundings and the bug didn't notice it. And the chameleon had both of it's eyes moving so it could see if anything was behind him like a predator. Next it has a very sticky tongue to grapple on to prey and fling them to it. Finally in the video I saw it's claws were round and i believe that is so that it can hold on to branches easier.

Score Points: 4

Scoring note:

The student has correctly described four ways that the parts of the chameleon help it survive [*the chameleon can blend into its surroundings, its eyes can see predators, and its sticky tongue grabs prey and its claws hold on to branches*] Note that "blending in" or "camouflage" refers to the chameleon's skin.

Student response #3:

The tounge is fast enough to catch food. It is long enough to to reach its food. It is sticky so he can grab it. He can change colors to blend in

Score Points: 4

Scoring note:

The student has correctly described four ways that the parts of the chameleon help it survive [*Its fast, long, sticky tongue helps it to catch food and it can change colors to blend in*]. Note that each attribute of the chameleon's tongue (fast, long, sticky) was counted as a separate way that the tongue helps the chameleon to catch food and survive.

Student response #4:

External:
What makes a chameleon survive externally is that it has a very long tongue that helps it catch prey that is far away or fast. Another external thing that chameleons have is a sticky tongue that helps when catching prey. Their tongue tongue reaches out and since it is so sticky it grabs on and holds tight to the bug it wants to eat.

Internal:
Chameleons have internal ways that help them survive. For instance, they have a very quick tongue that can reach out faster than a bug can get away so that their long and sticky tongue can grab it and eat it.

Score Points: 3

Scoring note:

The student has correctly described three ways that the parts of the chameleon help it survive [*its long, sticky, quick tongue helps to catch prey*]. Note that each attribute of the chameleon's tongue (long, sticky, quick) was counted as a separate way that the tongue helps the chameleon to catch food and survive. The student repeats the same ideas in both their external and internal sections and thus receives no additional credit.

Student response #5:

Its tongue helps it survive so it could like catch insects that are farther away. It uses its camafloge to hide from preditors or sneak up on its prey. It uses its feet to climb on trees and small branches. It also uses its tongue as a defence mechanisom to scar the enemy.

Score Points: 3

Scoring note:

The student has correctly described three ways that the parts of the chameleon help it survive [*the tongue helps it catch prey and the camouflage helps it hide from both predators and prey*]. Note that hiding from predators and hiding from prey were counted as separate ways the chameleon's skin helps it survive. Climbing was not considered necessary for survival. The tongue was not considered to be a defense mechanism.

Student response #6:

Four ways external and internal parts help the chameleon survive are the tongue, eyes, skin, habitat. It's tongue helps it get bugs farther away and its big eyes make it easier to see. The skin can make it so other animals can't see it. Depending on the area the chameleon lives in getting food can be easy or hard. These are four things externally and internally that help the chameleons survive in this certain environment.

Score Points: 3

Scoring note:

The student has correctly described three ways that the parts of the chameleon help it survive [*the tongue helps it to catch bugs, its eyes help it see and the skin helps it blend in so it cannot be seen*]. The habitat is not a part of the chameleon.

Student response #7:

The first way that chameleon use they ex and interial parts is they neck. Before they cach anytheing they use they neck to point what they catching. the also use they eye to see were they will be pointing or were what they willbe eating

Score Points: 2

Scoring note:

The student has correctly described two ways that the parts of the chameleon help it survive [*the neck points the head towards prey and the eyes see their food*].

Student response #8:

The parts of a chameleon that help it survive are its tongue,and his body wich is camoflouge. There tongue helps them so they can catch prey And food for there family. And there camoflouge body to hide from predetors. Other ways are the way chameleons look predetors might be scared. Also, there tongue is really fast.There body is also very long.

Score Points: 2

Scoring note:

The student has correctly described two ways that the parts of the chameleon help it survive [*the fast tongue helps it catch prey and its camouflage helps it hide from predators*]. The chameleon's body being long does not explain how that helps it survive.

Student response #9:

about the chameleon

the camouflage

your big tongue

were he live

you eyes that see around

Score Points: 2

Scoring note:

The student has correctly described two ways that the parts of the chameleon help it survive [*its camouflage and its eyes help it see*]. Note that "camouflage" can be considered both the part of the chameleon (the skin) and the way it helps it survive (blend in).

Student response #10:

A chameleon has many parts of its body that shall help survive and longer lifetime. One is its sticky tongue. They use their tongue the catch their prey. This is a main priotiry.

Score Points: 1

Scoring note:

The student has correctly described one way that the parts of the chameleon help it survive [*the sticky tongue helps it catch prey*].

Student response #11:

The first way is to have the chameleon somewhere where there is a lot bugs that the chameleon likes to eat. The second way is to keep the chameleon somewhere there are no predators that will eat the chemeleon or the chameleon can just go somewhere that there is green so the chameleon can match with it. The third way is to stay up high so no predators come and eat the chameleon. The fourth way is to

Score Points: 1

Scoring note:

The student has correctly described one way that the parts of the chameleon help it survive [matching with green]. Matching was considered camouflage. There were no other ways that parts of the chameleon help it to survive.

Student response #12:

internal

strong

- sticky
- long
- small

external

- chamafluge
- long toung
- green
- small

Score Points: 1

Scoring note:

The student has correctly described one way that the parts of the chameleon help it survive [*camouflage*]. Recall that camouflage counts both as a part of the chameleon and the way it helps it survive.

Student response #13:

The 4 ways of the extaral parts. the first way is theat the it is green secound is big third long toung and can climp trees those are the four parts of a chameleon

Score Points: 0

Scoring note:

The student fails to describe any ways that the parts of the chameleon help it survive. While the student mentions the chameleon's long tongue, there is no explanation of how it helps the chameleon survive.

Student response #14:

BY eating and living out in the wild.

Score Points: 0

Scoring note:

The student fails to describe any ways that the parts of the chameleon help it survive. There are no parts of the chameleon listed.

Student response #15:

The chameleon will survive by eating bugs. It will also survive by sleeping. Also by using the big tongue because it can chase people and catch up to people or animals easily. They will be resting by searching around and going to places.

Score Points: 0

Scoring note:

The student fails to describe any ways that the parts of the chameleon help it survive. While the student mentions the chameleon's "big tongue", there is no explanation of how it helps the chameleon survive.

NJSLA–S Grade 8
Rubric/Sample Responses
Sports Energy

A group of students is studying energy and motion in a science class. The students decide to use sports as the basis for their studies. To begin, the students find the masses of objects thrown in a variety of sports. Next, one of the students threw each type of ball. The other students measured the height at which each ball was released. Then they calculated potential energy for each ball at the moment it was released.

Table 1 lists the masses of the sports equipment and the results of the student investigation.

Table 1. Potential Energy versus Mass and Height

Object	Mass (kg)	Height (m)	Potential Energy (J)
Baseball	0.15	1.61	2.37
Softball	0.22	1.67	3.60
Football	0.40	1.63	6.39
Javelin	0.80	?	?
Discus	2.0	?	?
Shot put	7.2	?	?

Next, the students locate data about the relationship between mass, speed, and kinetic energy. Table 2 shows these data.

Table 2. Kinetic Energy versus Mass and Speed

Mass (kg)	Speed (m/s)	Kinetic Energy (J)
10	2	20
10	4	80
10	6	180
20	2	40
20	4	160
20	6	360
30	2	60
30	4	240

To show the relationship between kinetic energy and potential energy, students create a model of a baseball being thrown (Figure 1).

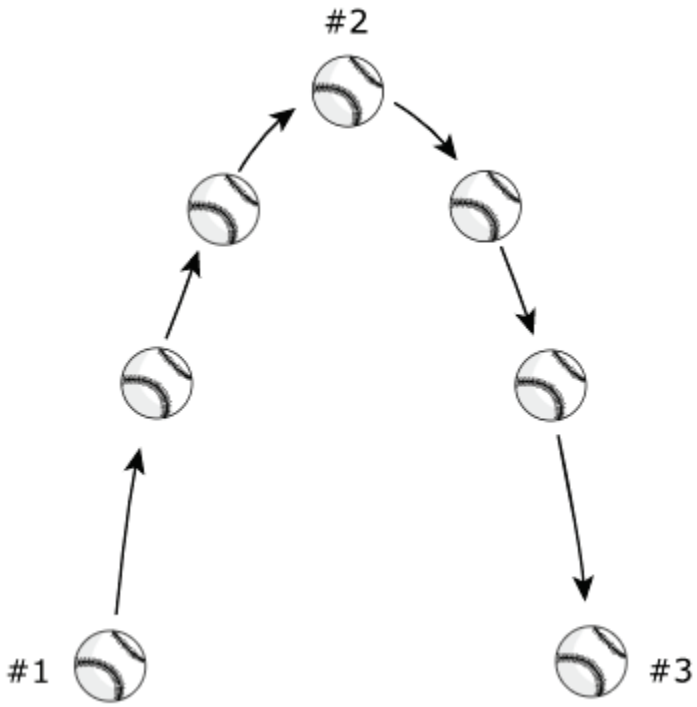

Figure 1. Baseball in Motion

A group of students creates a model that illustrates the potential energy in a system. Examine Figures 3 and 4, which show a shot put and a javelin being thrown.

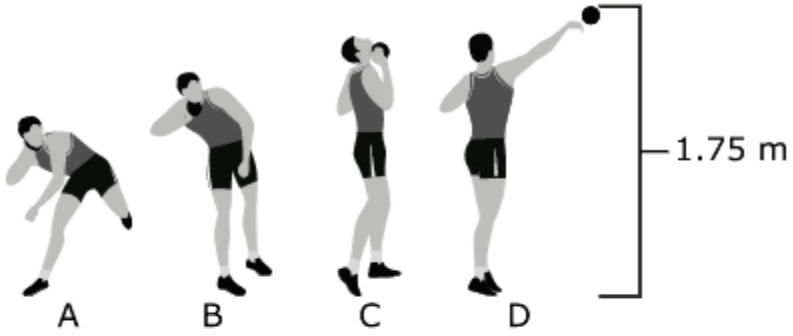

Figure 3. Shot Put

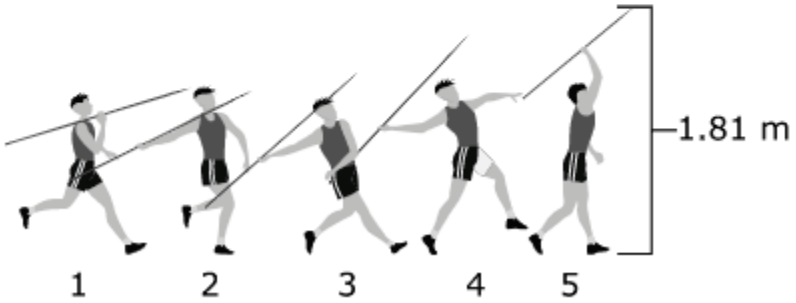

Figure 4. Javelin

Using the data from Table 1, determine what proportional relationship exists between mass and potential energy, as well as the proportional relationship between height and potential energy. Apply these relationships to predict which object—the shot put or the javelin—would have more potential energy. Then explain your prediction.

Enter your answer in the box. Support your answer with information from the data.

(Student response goes here)

Content alignment

Domain:
Physical Science

SEP Reporting Category:
Investigating

Phenomenon:
Potential energy is a result of an object's mass as well as its height above Earth.

NJSLA Standard:

MS-PS3 Energy

MS-PS3-2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. [Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.] [Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.]

SEP (Science and Engineering Practices):

UMCT Using mathematics and computational thinking

DCI (Disciplinary Core Ideas):

PS3.A Definitions of Energy

CCC (Crosscutting Concepts):

S, P, and **Q** Scale, proportion, and quantity

This item has 4 quality points:

- 1 point for explaining that potential energy is directly proportional to mass
- 1 point for explaining that potential energy is directly proportional to height
- 1 point for recognizing that the shot put has the greatest potential energy.
- 1 point for explaining that the significant difference in mass is the determining factor in the comparison.

4 quality points = a score of 4

3 quality points = a score of 3

2 quality points = a score of 2

1 quality point = a score of 1

0 quality points = a score of 0

Student response #1:

The larger the mass, the higher the potential energy. The higher the height, the higher the potential energy. Based on these relationships, the shot put would have more potential energy than the javelin, despite the javelin having a higher height. The javelin's mass is 0.8kg, while the shot put's is 7.2kg. The shot put weighs 6.4 kg more than the javelin, and the javelin is only thrown 0.06m heigher than the shot put. Therefore, the shot put has more potential energy.

Score Points: 4

Scoring note:

The student correctly explains that potential energy is directly proportional to mass [*The larger the mass, the higher the potential energy*] as well as to height [*The higher the height, the higher the potential energy*]. The student recognizes that the shot put has the greater potential energy [*the shot put would have more potential energy*] and explains that the significant difference in mass is the determining factor [*The shot put weighs 6.4 kg more*].

Student response #2:

If the mass of an object is greater, it will have a greater amount of potential energy as see in Table l. As the mass increases the potential energy it will have increases too. the height of the object differs, the baseball has a smallest height so the potential energy it has is the smallest too. Although the softball has a greater height, it's potential energy is not the greatest because of it's mass being average. The height of the football is not the greatest but since it has the greatest mass, it has the greatest amount of potential energy. The shot put would have a greater amount of potential energy than the javelin beacause a shot put has more mass than the javelin does which would cause it to have more potential energy.

Score Points: 4

Scoring note:

The student correctly explains that potential energy is directly proportional to mass [*As the mass increases the potential energy it will have increases*] as well as to height [*smallest height so the potential energy it has is the smallest*]. The student recognizes that the shot put has the greater potential energy [*the shot put would have a greater amount of potential energy*] and explains that the significant difference in mass is the determining factor [*a shot put has more mass than a javelin does*].

Student response #3:

The proportional relation between the mass and PE was that the heavier the object is the more PE the object stored before releasing. With height and PE, the realtionship is that when the object reached its maxium height it stored the most PE or that is the highset amount of potential energy. Javiln has little mass so little PE shot is the opposite.

Score Points: 4

Scoring note:

The student correctly explains that potential energy is directly proportional to mass [*the heavier the object is the more PE the object stored*] as well as to height [*its maximum height stored the most PE*]. The student recognizes that the shot put has the greater potential energy [*Javelin has little PE*] and explains that the significant difference in mass is the determining factor [*Javelin has little mass*]. Note that the student can state that the shot put has more PE/mass or that the javelin has less PE/mass to receive credit.

Student response #4:

Different relationships between potential energy change the amount of potential energy. In Table l, it shows that the more mass an object has, the more potential energy it will supply. In Figures 3 and 4, it shows that the height of object will affect how long the object remains in the air. Based on this information, it can be said that the shot put will have more potential energy. This can be said because the mass of the object is 7 times the weight of a javelin stick and since the mass is greater, the shot put will last longer in the air. Although, the height is a tad bit shorter than the javelin stick the object used for shot put will have the most potential energy.

Score Points: 3

Scoring note:

The student correctly explains that potential energy is directly proportional to mass [*the more mass an object has, the more potential energy*] but not to height. The student recognizes that the shot put has the greater potential energy [*the shot put will have more potential energy*] and explains that the significant difference in mass is the determining factor [*the mass of the object is 7 times the weight of a javelin*].

Student response #5:

The proportional relationship between mass and potential energy is that potential energy increases as mass increases. The proportional relationship between height and potential energy is that potential energy increases as height increases.

The shot put would have more potential energy because the shot put has a greater mass and reaches a greater height. As mentioned in the proportional relationships for mass and height compared to Potential Energy, the higher the mass/height, the greater the potential energy.

Score Points: 3

Scoring note:

The student correctly explains that potential energy is directly proportional to mass [*potential energy increases as mass increases*] as well as to height [*potential energy increases as height increases*]. The student recognizes that the shot put has the greater potential energy [*The shot put would have more potential energy*] but does not sufficiently explain that the significant difference in mass is the determining factor. The student attributes the shot put's higher potential energy to its greater mass and height. While the shot put does have a greater mass than the javelin, it does not reach a greater height.

Student response #6:

The more mass an object has, the greater it's potential energy due to gravity. Sijnce the Shot put has a similiar height to the Javelin, but a greater mass, the potential energy is going to be greater with the Shot put.

Score Points: 3

Scoring note:

The student correctly explains that potential energy is directly proportional to mass [*The more mass an object has, the greater its potential energy*] but not to height. The student recognizes that the shot put has the greater potential energy [*the potential energy is going to be greater with the Shot put*] and explains that the significant difference in mass is the determining factor [*the Shot put has a similar height to the Javelin, but a greater mass*].

Student response #7:

The javelin would have less potential energy because the mass is less than the shot put. 1.2 kg less than the shot. In the table the baeball had less mass than the football and the football had more potential energy. The height of the throw does not matter as much to find the potential energy but the javelin has more height than the shotput.

Score Points: 2

Scoring note:

The student does not explain that potential energy is directly proportional to mass or to height. The student recognizes that the shot put has the greater potential energy [*The javelin would have less potential energy*] and explains that the significant difference in mass is the determining factor [*the mass is less than the shot put*]. Note that the student can state that the shot put has more PE/mass or that the javelin has less PE/mass to receive credit.

Student response #8:

Mass has a huge impact on potential energy. If it is a larger mass, it is more likely to have less potential energy. The higher the height, the more the potential energy. I believe that the shotput would have more potential energy, since it can reach a higher height which would have a lot of potential energy. Also, shotput has less of a mass than javelin so it would be more likely to have more potential energy.

Score Points: 2

Scoring note:

The student correctly explains that potential energy is directly proportional to height [*The higher the height, the more the potential energy*] but not to mass. The student incorrectly states that a larger mass would have less potential energy. The student recognizes that the shot put has the greater potential energy [*the shotput would have more potential energy*] but does not explain that the significant difference in mass is the determining factor. The student incorrectly states that the shot put has less mass than the javelin.

Student response #9:

The more mass an object has, it seems as if it will end up having more potential energy. The more height an object has, the more potential energy it will have because the higher it gets the more potent

Score Points: 2

Scoring note:

The student correctly explains that potential energy is directly proportional to mass [*The more mass an object has … more potential energy*] as well as to height [*The more height an object has, the more potential energy*]. The student does not recognize that the shot put has the greater potential energy or explain that the significant difference in mass is the determining factor.

Student response #10:

The proportional relationship between mass and potential energy is that the more mass an object has, the harder it will be to make the object go high enough and gain GPE. If the object is heavier, it will be more dificult for someone to put enough force to make it go up. Also, the height affects the potential energy because the higher it is, the more potential energy it has. I belive the Javelin would have the most potential energy because on the chart it says that it has less mass than the Shot Put and went higher.

Score Points: 1

Scoring note:

The student correctly explains that potential energy is directly proportional to height [*the higher it is, the more potential energy it has*] but not to mass. The student incorrectly states that the javelin has the most potential energy because it has less mass.

Student response #11:

The proportional relationship that already exists is between mass and potential energy is that the more mass it has the more potential energy it has. It does not go up the same amount each time though. The relationship between height and potential energy is that it goes up six and down four each time. The object that could have more potential energy is the football because it had the biggest number when calculated.

Score Points: 1

Scoring note:

The student correctly explains that potential energy is directly proportional to mass [*the more mass it has the more potential energy it has*] but not to height. The student incorrectly states that the football has more potential energy and thus does not address the question.

Student response #12:

In the shot put A would have more potential energy because he brung it back so far. For the Javelin 3 Would give the pole the most potential energy because the farther you bring it back the more potential energy it will have.

Score Points: 1

Scoring note:

The student does not explain that potential energy is directly proportional to mass or to height. The student recognizes that the shot put has the greater potential energy [*the shot put A would have more potential energy*] but does not explain that the significant difference in mass is the determining factor.

Student response #13:

This relationship is not proportional. I believe that the Javelin has more potential energy. According to the pictures the javelin is being thrown farther by .6 m.

Score Points: 0

Scoring note:

The student neither explains that potential energy is directly proportional to mass nor to height. The student incorrectly states that the javelin has more potential energy because it is thrown further.

Student response #14:

The javelin will go father because its light and long and easier to throw.and since its smaller it has higher potential energy.The shot put dose have potential energy comming down as the javelin has little potential energy.

Score Points: 0

Scoring note:

The student neither explains that potential energy is directly proportional to mass nor to height. The student incorrectly states that the javelin has higher potential energy but also states that the javelin has little potential energy.

Student response #15:

The javelin would have more energy because it has more mass than the shot put

Score Points: 0

Scoring note:

The student neither explains that potential energy is directly proportional to mass nor to height. The student incorrectly states that the javelin has more energy because it has more mass.

NJSLA–S Grade 11
Rubric/Sample Responses
Glycogen

Two marathon runners of similar athletic capabilities are running a marathon. Runner 1 ate a large meal of pasta the night before the race. Runner 2 ate tuna fish and salad. After 100 minutes of the race, one runner is farther ahead than the other runner.

Proteins, carbohydrates, and fats are dietary components that are the three basic nutritional building blocks of food. All of these can be converted to glucose, which is the body's primary energy source.

Glucose can also be converted to glycogen, which is used as a source of energy while running when it is available, and stored in liver and muscle tissue.

Figure 1 shows the glycogen levels of the two runners and the distances they traveled during the first 100 minutes of the race.

Figure 1: Depletion Rate of Muscle Glycogen in the Runners over Time

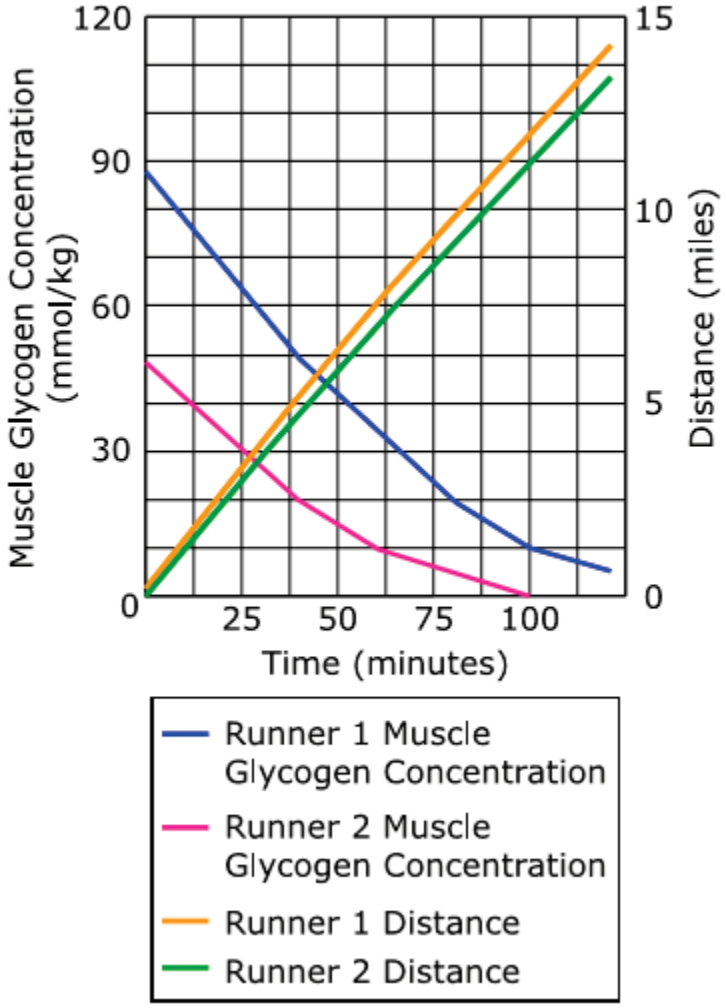

Table 1: Glycemic Indices of Runners' Meals

Runner 1	
Food	**Glycemic Index**
Macaroni	23
Sauce	1
Cheese	2
Apple	3
Runner 2	
Food	**Glycemic Index**
Tuna fish	0
Lettuce	0
Tomato	3
Salad dressing	2

The glycemic index of a food indicates how much blood glucose is produced by eating that food. Pure glucose has a glycemic index of 100.

Use the information provided in Figure 1 and the table to complete the following tasks.

Explain how the change in glycogen levels was different for each runner after 75 minutes of running.

Enter your answer in the box. Support your answer with evidence from the data.

(Student response goes here)

Identify the runner who ran the shorter distance over 100 minutes and how the food the runners ate resulted in the difference of distances traveled.

Enter your answer in the box. Support your answer with evidence from the data.

(Student response goes here)

Predict if the rate of running for Runner 2 will increase or decrease after 100 minutes, and explain why.

Enter your answer in the box. Support your answer with evidence from the data.

(Student response goes here)

Content alignment

Domain:
Life Science

SEP Reporting Category:
Critiquing

Phenomenon:
Two marathon runners of similar athletic capabilities are running a marathon. Runner 1 ate a large meal of pasta the night before training. Runner 2 ate tuna fish and salad. After 100 minutes of the race, one runner is farther ahead than the other runner.

NJSLA Standard:

HS-LS1/MEOE Matter and Energy in Organisms and Ecosystems

HS-LS1-7 Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy. [Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.] [Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.]

SEP (Science and Engineering Practices):

OECI Obtaining, evaluating, and communicating information

DCI (Disciplinary Core Ideas):

LS1.C Organization for Matter and Energy Flow in Organisms

CCC (Crosscutting Concepts):

E&M Energy and Matter: Flows, cycles, and conservation

This item has 4 quality points:

- 2 points (1 point for each runner) for explaining how the runners' glycogen levels were different after 75 minutes of running.
- 1 point for identifying Runner 2 as having traveled the shorter distance and describing how the food eaten by the runners correlates with the difference in distances traveled.
- 1 point for predicting if the rate of running for Runner 2 will increase or decrease, and for explaining why.

4 quality points = a score of 4

3 quality points = a score of 3

2 quality points = a score of 2

1 quality point = a score of 1

0 quality points = a score of 0

Student response #1:

Runner 1 started out with a higher glycogen concentration than Runner 2. After the first 75 minutes of running, both runners experienced a significent drop in the glycogen levels. Runner **1** experienced a change of 64 mmol/kg in 75 minutes. This is 0.89333 mmol/kglminute. Runner 2 experienced a change of 41 mmol/lg in 75 minutes. This is 0.546667 mmol/kg/minute. This shows how the change in glyvogen levels for Runner 1 happened more quickly than Runner 2. However, Runner **1** can allow this because he started out with higher levels in the first place.

Runner 2 ran the shorter distance over 100 minutes. Runner 2 ate tuna fish and a salad prior to running. This caused him to obtain lower glycogen levels than if he had eaten a meal containing more carbohydrates, like a large meal of pasta. This glycogen provided a source of energy while Runner 2 was running. Since Runner **1** ate a large pasts meal the night before, he was able to obtain higher glycogen levels, allowing him to run further in the first 100 minutes. Therefore, Runner 2's lower glycogen meal caused him to run a shorter difference in the first 100 minutes.

The rate for Runner 2 will decrease after the first 100 minutes. This is because once he reached the 100 minute mark, his body has already ran out of glycogen. This was his main energy source that was allowing him to run the speed that he was going. Since he no longer has any glycogen to provide enery, he wiII show a significant decrease in speed after the first 100 minutes of running**.**

Score Points: 4

Scoring note:

This student explains how the change in glycogen levels was different after 75 minutes for Runner 1 [*Runner 1 experienced a change of 64 mmol/kg in 75 minutes*] and Runner 2 [*Runner 2 experienced a change of 41 mmol/kg in 75 minutes*]. The student also identifies Runner 2 as the runner who ran the shorter distance over 100 minutes and explains how the food the runners ate resulted in the difference of distances travelled [*Since Runner 1 ate a large pasta meal the night before he was able to obtain higher glycogen levels*]. The student predicts that the rate of running for Runner 2 will decrease after 100 minutes and explains why [*once he has reached the 100 minute mark, his body has already ran out of glycogen*].

Student response #2:

The change of glycogen levels was higher in Runner 1 after 75 minutes but he or she had a higher starting posiston of Muscle Glycogen Concentration so they still had more than Runner 2, who in this case, didn't lose their glycogen levels as quickly but had less to start with and in turn, less than Runner 1 after 75 minutes.

Runner 2 ran the shorter distance than Runner 1 because runner 1 had the high levels of Muscle Glycogen Concentrations due to eating foods with high glucose levels.

The rate will most likely decrease because eventually the Glycogen concentrations will be depleted and the runner will feel fatigued.

Score Points: 4

Scoring note:

This student explains how the change in glycogen levels was different after 75 minutes for Runner 1 [*The change of glycogen levels was higher in Runner 1 after 75 minutes*] and Runner 2 [*Runner 2 didn't lose their glycogen levels as quickly*]. The student also identifies Runner 2 as the runner who ran the shorter distance over 100 minutes and explains how the food the runners ate resulted in the difference of distances travelled [*Runner 1 had the high levels of muscle glycogen concentrations due to eating foods with high glucose levels*]. The student predicts that the rate of running for Runner 2 will decrease after 100 minutes and explains why [*eventually the glycogen concentrations will be depleted*].

Student response #3:

As each runner ran there glycolic concentrations went down. Specifically as Runner 1 ran their glycolic concentration went from 90 and then decreased to about 30 at the 75 minute mark. Runner 2 had started with a glycolic conecntration of about 55 and decreased to less than 5 after 75 minutes of running.

Runner 2 ran a shorter distance. This makes sense since the food their ate was less glycolically concentrationed than runner 1.

It will decrease since they have less muslce glycogen concentration. As is their distance is going down and will continue to d so in the future.

Score Points: 4

Scoring note:

This student explains how the change in glycogen levels was different after 75 minutes for Runner 1 [*As Runner 1 ran their glycolic concentration went from 90 and then decreased to about 30*] and Runner 2 [*Runner 2 had started with a glycolic concentration of about 55 and decreased to less than 5*]. The student also identifies Runner 2 as the runner who ran the shorter distance over 100 minutes and explains how the food the runners ate resulted in the difference of distances travelled [*the food they ate was less glycolically concentrated than Runner 1*]. The student predicts that the rate of running for Runner 2 will decrease after 100 minutes and explains why [*they have less muscle glycogen concentration*].

Student response #4:

Runner 1 had a lot greater concentration of glycogen at the beginning of the race, so his glycogen level decreased a greater amount after 75 minutes because he had more to start with than runner 2 had.

Runner 2 ran a shorter distance in the 100 minutes because the food he ate had a lower level of glycogen which helped runner one run a greater distance in the 100 minutes that they ran. So the more glycogen in the meal they ate resulted in runner 1 getting farther because he had a greater concentration of glycogen.

It will decrease because his levels of glycogen are very low and will only get lower.

Score Points: 3

Scoring note:

This student explains how the change in glycogen levels was different after 75 minutes for Runner 1 [*his glycogen level decreased a greater amount*] but not for Runner 2. The student also identifies Runner 2 as the runner who ran the shorter distance over 100 minutes and explains how the food the runners ate resulted in the difference of distances travelled [*the food he ate had a lower level of glycogen*]. The student predicts that the rate of running for Runner 2 will decrease after 100 minutes and explains why [*his levels of glycogen are very low and will only get lower*].

Student response #5:

The glycogen levels were different for each runner after 75 minutes of running because since each runner had a different meal which resulted in different amounts of protein, fats, and carbohydrates even though the calories were off by 2 their can have a major difference in the levels. After 75 minutes, Runner 1 levels even though are higher than Runner 2 they are dropping more than Runner 2.

Runner 2 ran the shortest distance compared to Runner 1. This is probably due to the lack of glycemic index the food the runner ate. Runner one probably had more energy due to the food it ate which resulted in a longer distance ran.

I predict that Runner 2 rate of running will decrease since the food the runner ate probably didnt give enough energy and lacked glycemic index. As you see in the graph, Runner 2 line is slightly below Runner 1 but the slope is decreasing which is showing that the runner is slowing down.

Score Points: 3

Scoring note:

This student explains how the change in glycogen levels was different after 75 minutes for Runner 1 [*After 75 minutes, Runner 1 levels even though they are higher than Runner 2 they are dropping more than Runner 2*] but not Runner 2. The student also identifies Runner 2 as the runner who ran the shorter distance over 100 minutes and explains how the food the runners ate resulted in the difference of distances travelled [*the lack of glycemic index of the food the runner ate*]. The student predicts that the rate of running for Runner 2 will decrease after 100 minutes and explains why [*Runner 2 line is slightly below Runner 1 but the slope is decreasing which is showing that the runner is slowing down*].

Student response #6:

After 75 minutes, runner 1 's glycogen concentration was at about 25, it started off arounf 90. Runner 2's glycogen concentration started off around 50 and dropped to around 5.

Runner 2 ran the shorter distance because they had a lower glycogen concentration level.

It will decrease because of their lower glycogen levels.

Score Points: 3

Scoring note:

This student explains how the change in glycogen levels was different after 75 minutes for Runner 1 [*After 75 minutes, Runner 1's glycogen concentration was at about 25, it started off around 90*] and Runner 2 [*Runner 2's glycogen concentration started off around 50 and dropped to around 5*]. The student also identifies Runner 2 as the runner who ran the shorter distance over 100 minutes but does not explain how the food the runners ate resulted in the difference of distances travelled. The student predicts that the rate of running for Runner 2 will decrease after 100 minutes and explains why [*because of their low glycogen levels*].

Student response #7:

runner 1's glycogen levels changed faster than runner 2's.

runner 2 ran less, because the food eaten by runner 2 had a lower glyccemic index than runner 1. therefore, less energy was available to runner 2.

decrease, no more glycogen in muscles, therefore, no energy left.

Score Points: 2

Scoring note:

This student does not clearly explain how the change in glycogen levels was different after 75 minutes for Runner 1 or Runner 2. The student identifies Runner 2 as the runner who ran the shorter distance over 100 minutes and explains how the food the runners ate resulted in the difference of distances travelled [*the food eaten by Runner 2 had a lower glycemic index than Runner 1*]. The student also predicts that the rate of running for Runner 2 will decrease after 100 minutes and explains why [*no more glycogen in muscles, therefore, no energy left*].

Student response #8:

The change is glycogen leves was different for each runner after 75 minutes because they each ate different foods and had different muscle glycogen concentration when they began the race

Runner 2 ran the shorter distance over 100 minutes. The food the runners ate resulted in the difference of distances traveled because Runner 1 had more carbohydrates to sustain energy long enough to run a long distance over a long period of time, whereas Runner 2 had more protein.

The rate of running for Runner 2 will decrease because he will slowly become much more tired since he didnot consume the correct amount of carbohydrates before his run.

Score Points: 2

Scoring note:

This student does not explain how the change in glycogen levels was different after 75 minutes for Runner 1 or Runner 2. The student identifies Runner 2 as the runner who ran the shorter distance over 100 minutes and explains how the food the runners ate resulted in the difference of distances travelled [*Runner 1 had more carbohydrates to sustain energy long enough to run a long distance*]. The student also predicts that the rate of running for Runner 2 will decrease after 100 minutes and explains why [*he will slowly become much more tired because he did not consume the correct amount of carbohydrates*].

Student response #9:

After 75 minutes of running runner 1 had a Muscle glycogen concentration of about 22 while runner 2 had less than 10.

Runner 2 ran a shorter distance because he had less glycogen in his food

The rate of running will decrease becase he will have little to no glycogen left in his body

Score Points: 2

Scoring note:

This student does not explain how the change in glycogen levels was different after 75 minutes for Runner 1 or Runner 2. The student identifies Runner 2 as the runner who ran the shorter distance over 100 minutes and explains how the food the runners ate resulted in the difference of distances travelled [*he had less glycogen in his food*]. The student also predicts that the rate of running for Runner 2 will decrease after 100 minutes and explains why [*he will have little to no glycogen left in his body*].

Student response #10:

Runner 1 had twice as much concentration after 75 minutes.

Runner 2 ran a shorter distance because he was going at a slower rate than Runner 1.

The rate will decrease because the concentration will run out.

Score Points: 1

Scoring note:

This student does not explain how the change in glycogen levels was different after 75 minutes for Runner 1 or Runner 2. The student identifies Runner 2 as the runner who ran the shorter distance over 100 minutes but does not explain how the food the runners ate resulted in the difference of distances travelled. The student predicts that the rate of running for Runner 2 will decrease after 100 minutes and explains why [*the concentration will run out*].

Student response #11:

The food that Runner 1 ate before the marathon gave him a higher glycogen amount.

Runner 2 ran a shorter distance because his food gave him no glycogen stores.

It will not, because Runner 2 is losing energy; not gaining it.

Score Points: 1

Scoring note:

This student does not explain how the change in glycogen levels was different after 75 minutes for Runner 1 or Runner 2. The student identifies Runner 2 as the runner who ran the shorter distance over 100 minutes and explains how the food the runners ate resulted in the difference of distances travelled [*his food gave him no glycogen stores*]. The student does not clearly predict that the rate of running for Runner 2 will decrease after 100 minutes or explain why.

Student response #12:

runner 2s muscle glycogen concentration levels decreased as runner number 1s have increased signefigancly then runner number 2.

runner number 1 ran a longer distance then runner number 2. Runner number 2 didnt have the same amount of muscle glycogen as runner number 1 had.

Runner number 2 will decrease after 100 minutes because of his muscle glycogen concentration because it is lower then runner number 1s.

Score Points: 1

Scoring note:

This student does not explain how the change in glycogen levels was different after 75 minutes for Runner 1 or Runner 2. The student identifies Runner 1 as the runner who ran a longer distance over 100 minutes but does not explain how the food the runners ate resulted in the difference of distances travelled. Note that it is acceptable for the student to indicate that Runner 2 ran a shorter distance or that Runner 1 ran a longer distance. The student also predicts that the rate of running for Runner 2 will decrease after 100 minutes and explains why [*his muscle glycogen concentration is lower than Runner 1*].

Student response #13:

Because they both had dfferent diets and each diet had different glycemic index and different amount which affects their body and abilities differently. Thats why it affected their 75 minutes running time.

Runner 2 ran shorter distance over 100 minutes because as you can see in the graph runner 1 had lower glycogen concentration over 100 minutes.

It will decrease.

Score Points: 0

Scoring note:

This student does not explain how the change in glycogen levels was different after 75 minutes for Runner 1 or Runner 2. The student identifies Runner 2 as the runner who ran the shorter distance over 100 minutes but does not explain how the food the runners ate resulted in the difference of distances travelled. The student also predicts that the rate of running for Runner 2 will decrease after 100 minutes but does not explain why.

Student response #14:

runner 1's glycogen level was higher then runner 2's as a result runner 1 ran a greater distance

runner 2 ran the shorter distance bewteen the two

i don't really know why

Score Points: 0

Scoring note:

This student does not explain how the change in glycogen levels was different after 75 minutes for Runner 1 or Runner 2. The student identifies Runner 2 as the runner who ran the shorter distance over 100 minutes but does not explain how the food the runners ate resulted in the difference of distances travelled. The student does not predict that the rate of running for Runner 2 will decrease after 100 minutes or explain why.

Student response #15:

Runner 1 had a higher glycogen level then runner 2, runner 1 had a 22 mmol of glycogen and runner 2 had 7mmol. they have a 15 difference betweem their glyogen level.

Runer 1 ran a higher distance over 100 min because of his glycemic index. His glycemic index of food was lower than runner 2.

it will decrease

Score Points: 0

Scoring note:

This student does not explain how the change in glycogen levels was different after 75 minutes for Runner 1 or Runner 2. The student identifies Runner 1 as the runner who ran a longer distance over 100 minutes but incorrectly states that the glycemic index of his food was lower. The student predicts that the rate of running for Runner 2 will decrease after 100 minutes but does not explain why.