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ABSTRACT

The Delaware Student Testing Program (DSTP) is designed to assess progress toward the Delaware Content Standards. Every year a certain number of items are removed from the test and then selected for public release. This booklet contains items released from the 2001 administration of the DSTP Science tests for grades 8 and 11. It contains examples of questions that represent the range of difficulty and type of item that appear on the science portion of the DSTP. Items measure these eight content standards: (1) Nature and Application of Science and Technology; (2) Materials and Their Properties; (3) Energy and Its Effects; (4) Earth in Space; (5) Earths Dynamic Systems; (6) Life Processes; (7) Diversity and Continuity of Living Things; and (8) Ecology. These released items include the question, the scoring criteria, and anchor papers for each score point. (SLD)

January 2002

DELAWARE

STUDENT TESTING PROGRAM

ITEM SAMPLER

RELEASED ITEMS FOR SCIENCE

Grades 8 and 11

Delaware Department of Education

Document Number 95-01/02/01/21

SCIENCE

Delaware Student Testing Program (DSTP)

The Science DSTP

The purpose of this sampler is to provide Delaware teachers and educators with information about the science test administered in the 8th and 11th grades. It contains examples of questions that represent the range of difficulty and type of item that appear on the science portion of the Delaware Student Testing Program (DSTP).

Items on the Science portion of the DSTP:

Measure all eight (8) content standards:

- Nature and Application of Science and Technology
- Materials and Their Properties
- Energy and Its Effects
- Earth in Space
- Earth's Dynamic Systems
- Life Processes
- Diversity and Continuity of Living Things
- Ecology

Measure the standard at the grade cluster level

Item Types

The science test includes 32 multiple choice items, which are scored on a scale point range of 1-0, and 18 short answer (constructed response) items, which are scored on a scale point range of 2-1-0.

The science test assesses scientific capabilities, knowledge, and understanding. Students are asked to interpret or create charts, graphs, tables, and simple diagrams or other visual representations. In some instances, students are asked to group, sort, and classify objects or organisms based on similarities or physical properties. In other instances, they are asked to provide or identify evidence, interpret a simple model, describe or identify an event or sequence of events, draw conclusions from data, and generate an explanation. One-word responses do not constitute a full explanation. Students who produce incomplete descriptions or vague explanations do not receive full credit for their responses. Appropriate vocabulary, while desirable, is not essential provided that students show conceptual understanding in their written response. Every item on the test is coded to the Delaware science content standards. All items have

been written and edited by Delaware teachers and educators and have been approved by a Bias Committee and Science Content Advisory Committee.

SCIENCE

Item Sampler

In the benchmarking process, Delaware teachers read each short answer question and rubric and then examine a range of student responses to the question. The result is the compilation of anchor papers that are used in conjunction with the scoring tool by Harcourt Educational Measurement to score Delaware responses to the DSTP in science. Delaware teachers select anchor papers for each possible score point, i.e., 2-1-0 points. The following set of released items from the 2001 DSTP include the question, the scoring criteria, and anchor papers for each score point.

Life Processes – Structure/Function Relationship

In the elementary curriculum, students learn that offspring are like their parents. That is, crayfish produce crayfish and bean plants produce bean plants. During middle school, student understanding of organisms moves from the macroscopic level to a basic cellular level. Similar cells that have the same structures produce cells that perform the same functions. For example, liver cells produce liver cells that aid in digestion while skin cells produce skin cells that function as a protective barrier for the organism. Comparing different tissue types, such as lung and epithelial skin cells, helps students to understand that as cells grow and divide in multi-cellular organisms, the cells aggregate to form tissues that perform specialized functions.

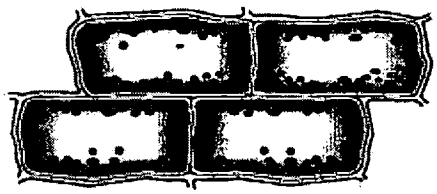
What is often problematic for middle school students is the transition from the macroscopic to the microscopic. Without certain instructional experiences, students will not develop an understanding that cells are the fundamental building blocks of life. By providing opportunities to view a variety of cells from single and multi-cellular organisms, students will learn that all living things, including their bodies, are made up of cells. A single-celled organism can carry out all functions of a multi-cellular organism.

Item #1—Structure/Function Relationship

This question measures student understanding of Structure/Function Relationship, under Life Processes, Standard #6.

> "***1. The basic unit of all living organisms is the cell. In multi-cellular organisms, different cells are specialized to perform various tasks, and cells similar in shape and function are organized into groups (e.g., muscle cells, motor nerve cells).***
>
> ***2. Cells contain a set of observable structures called organelles (e.g., cell wall, cell membrane, nucleus, chloroplast, and vacuole) that control the various functions of the cell such as structural support, exchange of materials, photosynthesis, and storage of essential materials.***
>
> ***3. Unicellular organisms perform, within a single cell, all of life's specific functions such as water regulation, digestion, locomotion, and circulation using specialized structures for each function."***

Paramecium



Cells from a plant

Explain why the cell is said to be the basic unit of all living things.

Rubric:

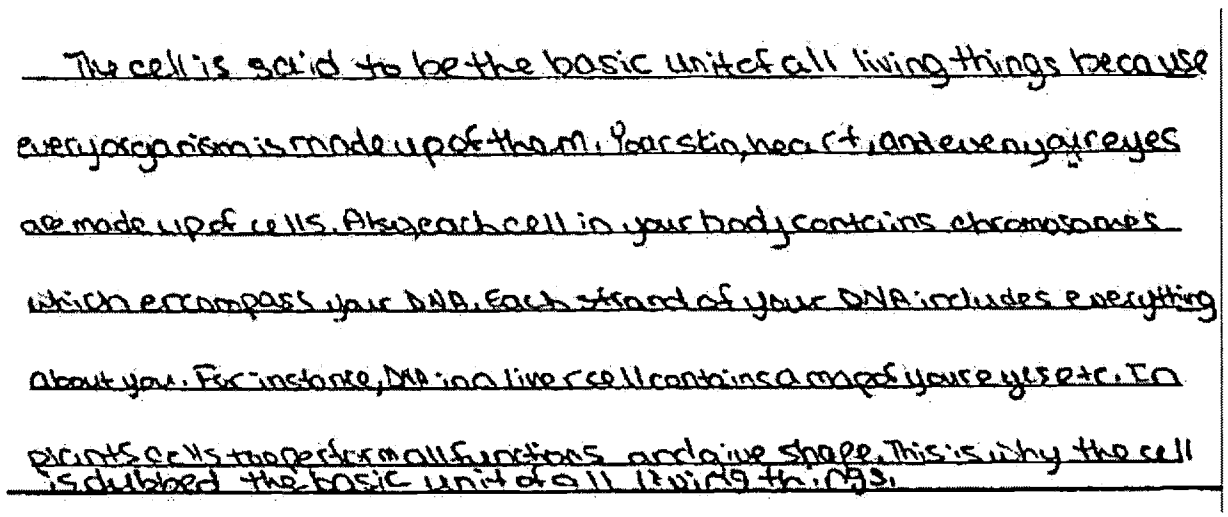
Score Point 2 – Student explains that all living things are made of cells, that cells are the basic unit of structure **AND** function of all living things **AND** that all cells come from other cells, or any other scientifically accurate response.

Score Point 1 – Partially correct, e.g., student explanation includes the idea that all living things are made of cells.

Score Point 0 – Inappropriate or incorrect response.

Score Point 2 – Student explains that all living things are made of cells, that cells are the basic unit of structure **AND** function of all living things **AND** that all cells come from other cells, or any other scientifically accurate response.

The following three student responses received two points for their answers.


The cell is said to be the basic unit of all living things because every organism is made up of them. Your skin, heart, and even your eyes are made up of cells. Also, each cell in your body contains chromosomes which encompass your DNA. Each strand of your DNA includes everything about you. For instance, DNA in a liver cell contains a map of your eyes etc. In plants cells too perform all functions and give shape. This is why the cell is dubbed the basic unit of all living things.

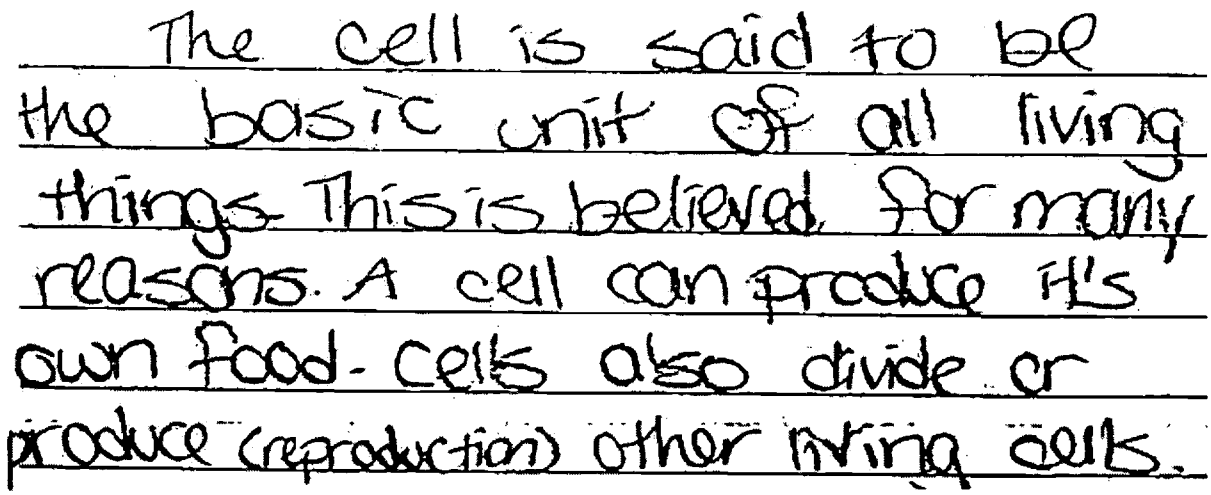
"The cell is said to be the basic unit of all living things because every organism is made up of them. Your skin, heart, and even your eyes are made up of cells. Also, each cell in your body contains chromosomes which encompass your DNA. Each strand of your DNA includes everything about you. For instance, DNA in a liver cell contains a map of your eyes, etc. In plants cells too perform all functions and give shape. This is why the cell is dubbed the basic unit of all living things." The response indicates a deep understanding that all living things are comprised of cells and that these different cells make up different organs that perform different functions. In addition, this response shows that the student understands that plants, too, are comprised of cells that perform certain functions. This response exceeds the expectation of the rubric in its further elaboration of the function of DNA.

Score Point 2 – Student explains that all living things are made of cells, that cells are the basic unit of structure **AND** function of all living things **AND** that all cells come from other cells, or any other scientifically accurate response.

Cells make up all parts of all living this, and each does a simple task; either reproducing itself, digesting food, fighting viruses, or something else. Without them, there would be no life.

"Cells make up all parts of all living this (sic), and each does a simple task; either reproducing itself, digesting food, fighting viruses, or something else. Without them, there would be no life." This response demonstrates knowledge that all living things are comprised of cells that perform different functions for the organism and details some of those functions.

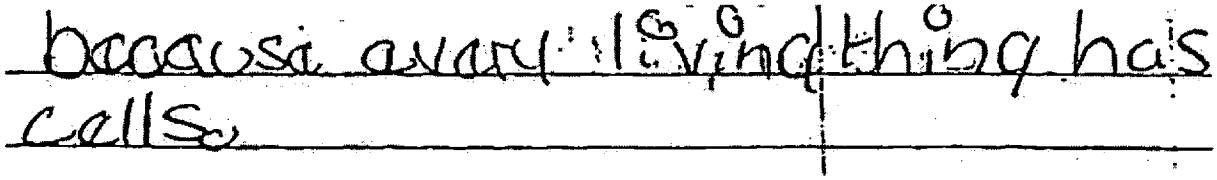
Score Point 2 – Student explains that all living things are made of cells, that cells are the basic unit of structure **AND** function of all living things **AND** that all cells come from other cells, or any other scientifically accurate response.



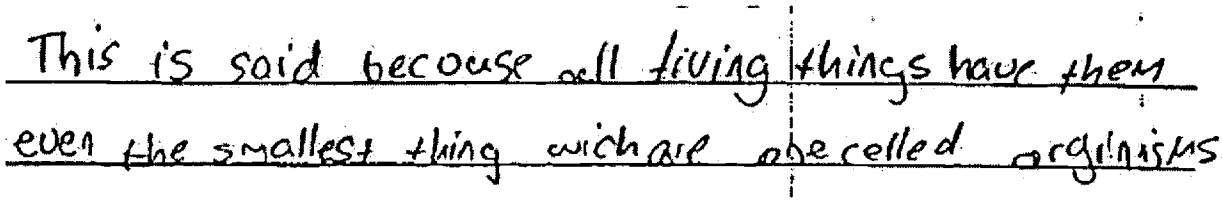
"The cell is said to be the basic unit of all living things. This is believed for many reasons. A cell can produce it's (sic) own food – cells also divide or produce (reproduction) other living cells." This response meets the criteria for this rubric by providing two reasons why cells are the basic unit of living things: the implied plant cell that produces its own food (photosynthesis) and the fact that all cells produce new cells.

Score Point 1 – Partially correct, e.g., student explanation includes the idea that all living things are made of cells.

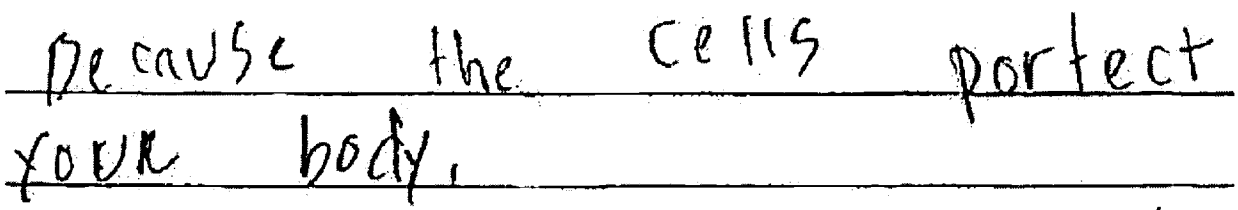
The following three student responses received one point for their answers.



"because (sic) every living thing has cells." This response earns one point for its minimal knowledge that all living things have cells.



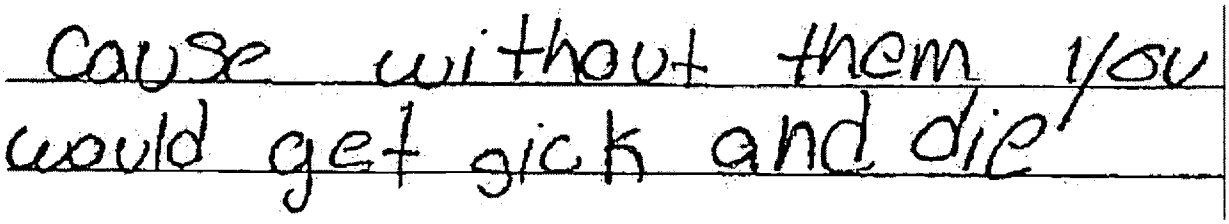
"This is said because all living things have them even the smallest thing wich (sic) are one celled organisms." The student indicated an understanding that all living things, regardless of size, are composed of cells. The student does not connect the structure of cells to their functions for organisms or explain that similar cells produce similar cells.



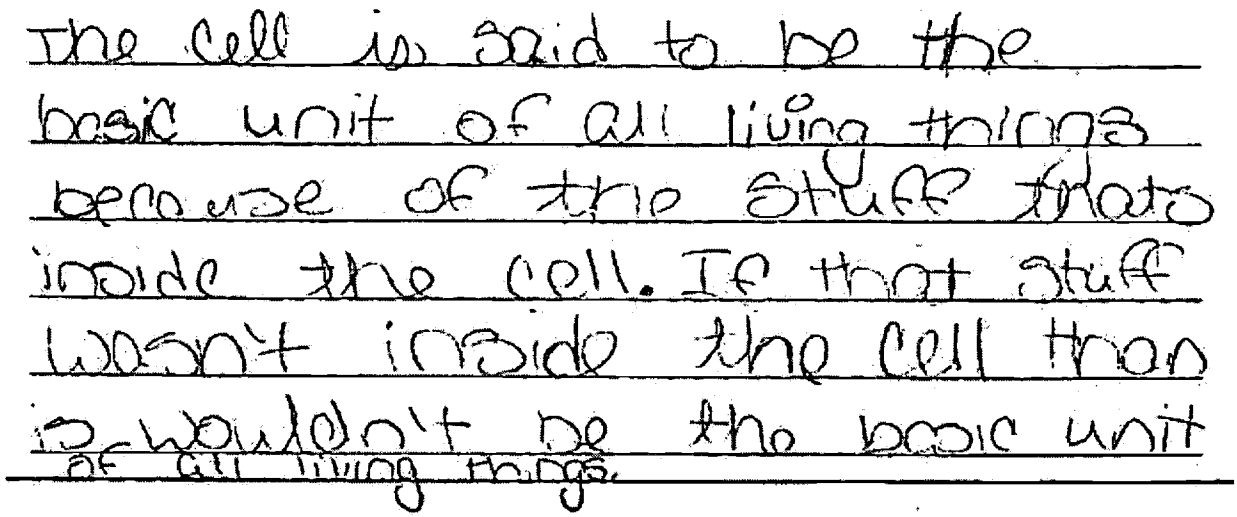
"Because the cells portect (sic) your body." As this response illustrates, at the very minimum, students could earn one point by providing one way that cells function without specifying which cells perform this function nor how similar cells produce similar cells.

Score Point 0 – Inappropriate or incorrect response.

The following three student responses received no points for their answers.

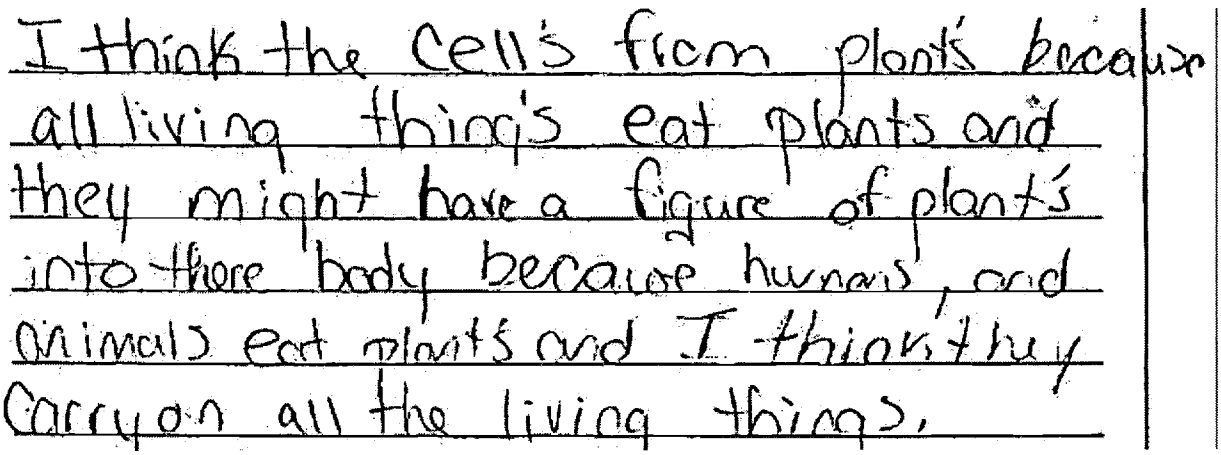


"Cause without them you would get sick and die." In this response, the student does not explain even one reason why organisms would not be alive without cells, nor does the response indicate that pre-existing cells produce new cells. Instead, this response represents the tautological way that some students reason.



"The cell is said to be the basic unit of all living things because of the stuff thats (sic) inside the cell. If that stuff wasn't inside the cell than is (sic) wouldn't be the basic unit of all living things. In this response, the student is vague in explaining how various cells conduct life processes and produce new cells.

Score Point 0 – Inappropriate or incorrect response.



"I think the cell's (sic) from plant's (sic) because all living things eat plants and they might have a figure of plant's (sic) into there (sic) body because humans and animals eat plant's (sic) and I think they carry on all the living things." In this response, the student appears to answer in terms of a transformation of matter in a food chain from plants to animals and humans. The student response suggests that the cells in humans and animals are ingested and in that way becomes part of the higher organism. The response reveals a major misconception that cells are transmitted via the food chain and shows no correct understanding of cellular reproduction.

Materials and Their Properties – Mixtures and Solutions

Students have experiences observing and describing physical properties of substances in the elementary years. However, learning about the characteristic properties is fundamental in the middle school. Students investigate density, solubility, melting, freezing, and boiling points of common substances. They study mass and volume and learn which properties remain constant and which ones change when exposed to different conditions. An understanding of the particle model is critical in order for students to be prepared for the more abstract molecular model that is appropriate to high school students. Students need to visualize the behavior of "particles" as they change phase as well as their even distribution when dissolved in another substance.

Application of separating techniques related to the properties of substances is one objective of the middle school science curriculum. Students need experiences measuring and separating matter that is not visible to the eye (such as salt dissolved in water). Boiling or evaporating a saltwater solution is one way to separate the component substances; condensing and collecting the water is important if one is to underscore the concept of the conservation of matter. In order to develop a real understanding, students must make these abstract concepts concrete by physically performing such tasks in the classroom.

Item #2—Mixtures and Solutions

This question measures student understanding of Mixtures and Solutions, under Materials and Their Properties, Standard #2.

> ***"Mixtures have component parts. Most natural materials such as milk, blood, mineral ores, sea water, soil and air; and man-made materials, such as processed foods, cosmetics, and paints are physical mixtures consisting of a variety of components in a wide range of concentrations. The individual components can be analyzed and separated by making use of their unique chemical and physical properties."***

Question:

A ship in the middle of the ocean runs out of fresh drinking water. How could some fresh drinking water be made from the ocean water?

Rubric:

Score Point 2 – Heat water to boiling and condense and collect the steam; collect condensed water (as on a cold surface) that has evaporated from the water or any other scientifically valid method that uses ocean water.

Score Point 1 – Student knows to separate salt from the water but the separation technique does not yield fresh water.

Score Point 0 – Inappropriate or incorrect response.

Score Point 2 – Heat water to boiling and condense and collect the steam; collect condensed water (as on a cold surface) that has evaporated from the water or any other scientifically valid method that uses ocean water

The following three student responses received two points for their answers.

You could take the sea water and boil it under some thing smooth and sits on an angle. The water will condence on the overhead object roll down the side into another object to hold the water. The salt will be left in the boiling pot.

"You could take the sea water and boil it under some thing smooth and sits on an angle. The water will condence (sic) on the overhead object roll down the side into another object to hold the water. The salt will be left in the boiling pot." This response describes a technique for separating the salt from the water and collecting the water through condensation on a surface that drips into a container of some sort.

They could place a plastic sheet over a pot of water, have the plastic run to another pot. The sun evaporates the water the plastic catches it and runs it to a second pot.

"They could place a plastic sheet over a pot of water, have the plastic run to another pot. The sun evaporates the water the plastic catches it and runs it to a second pot." This response demonstrates another technique for separating salt from water through evaporation and then the collection of the fresh water. This response and the one above it strongly suggest that students have actually conducted similar separation techniques in the classroom that enable them to transfer their knowledge to an out of school context.

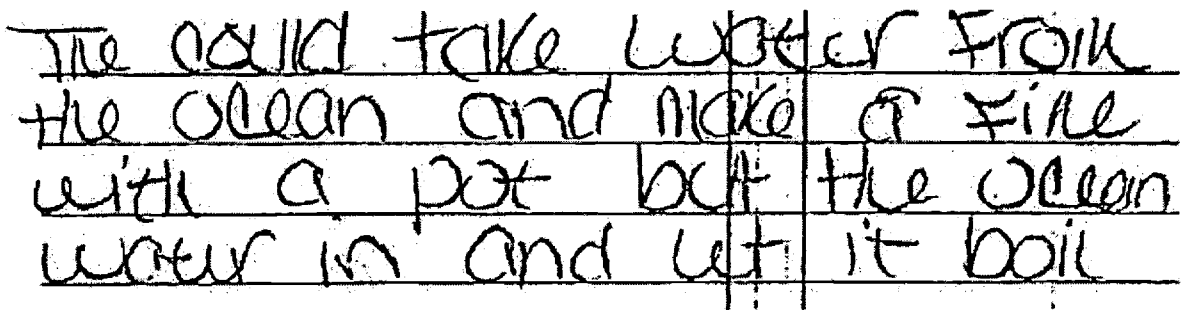
Score Point 2 – Heat water to boiling and condense and collect the steam; collect condensed water (as on a cold surface) that has evaporated from the water or any other scientifically valid method that uses ocean water

Put salt water in a dish in the middle of a pyramid of cellophane. Then it evaporates and the salt is left behind. The water runs down the side of the cellophane and is collected in a tray. Now it is fresh to drink.

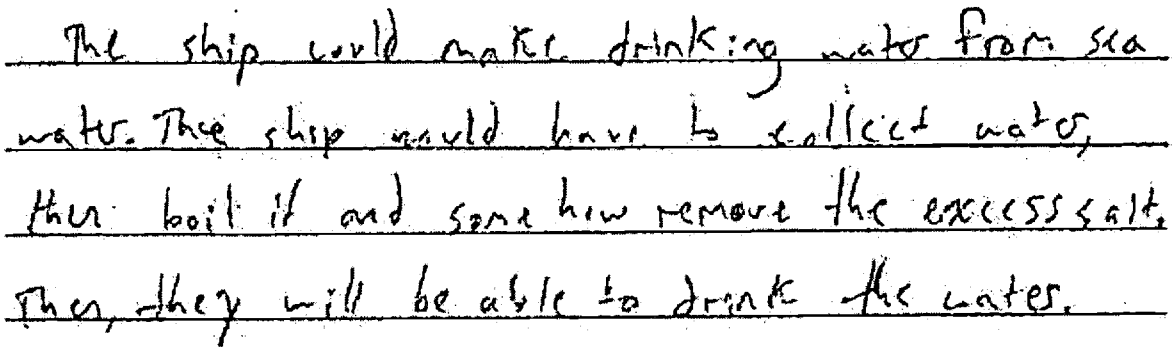
"Put salt water in a dish in the middle of a pyramid of cellophane. Then it evaporates and the salt is left behind. The water runs down the side of the cellophane and is collected in a tray. Now it is fresh to drink." This response shows a variation on a technique that will also work to separate the salt from the water through evaporation and then collecting the water on a surface from which it can drain into a container.

Score Point 1 – Student knows to separate salt from the water but the separation technique does not yield fresh water.

The following four student responses received one point for their answers.



"The (sic) could take water from the ocean and make a fire with a pot but (sic) the ocean water in and let it boil." In this response, the student describes an accurate method for separating the salt from the water through boiling; however, the student does not provide any method for collecting the water.

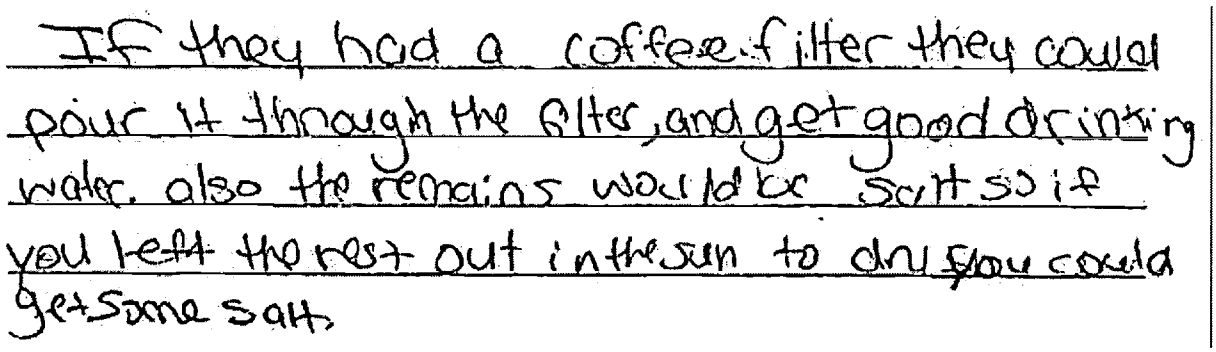


"The ship could make drinking water from sea water. The ship would have to collect water, then boil it and some how remove the excess salt. Then, they will be able to drink the water." This response provides one technique of separating the solution through boiling. However, it also reveals some lack of understanding on the part of the student when it is noted that "somehow" the excess salt needs to be removed. The student may be thinking that boiling the water will kill harmful bacteria but then there still needs to be a way to extract the salt because they understand that the salt must be removed to make it fresh water; or the student may be thinking that boiling will separate some of the salt but not all of it, so there is "excess" to remove; or the student may be stuck trying to figure out where the salt is going to be and where the fresh water is going to be after the boiling. The weakness of the response stems from the student's vagueness about the details of separating this solution and perhaps inexperience with this

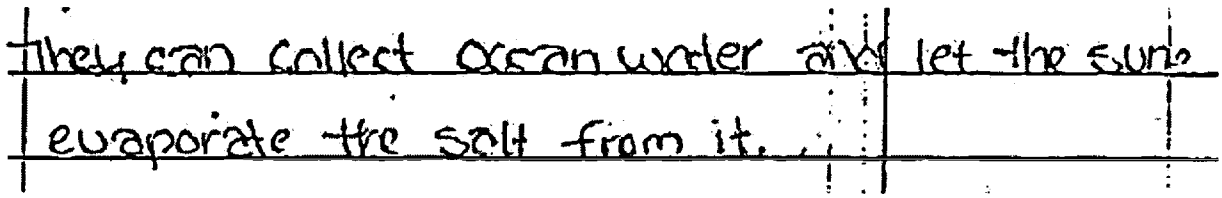
kind of activity.

GRADE 8 — STANDARD #2 SHORT ANSWER

Score Point 1 – Student knows to separate salt from the water but the separation technique does not yield fresh water.



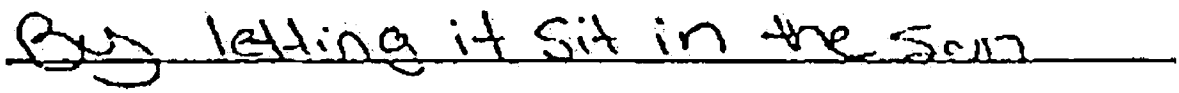
"If they had a coffee filter they could pour it through the filter, and get good drinking water. Also the remains would be salt so if you left the rest out in the sun to dry you could get some salt." In this response, the student suggests one way to separate the salt from the seawater through evaporation. The response indicates no way to collect the fresh water for drinking. The student also identifies the use of a filter to separate the salt from the water but then notes that salt would still "remain." This response indicates that the student does not fully grasp the connection between particle size in relation to filters. If the particles are too small, they will not be separated using a coffee filter. Nor does the student, on the basis of this response, appear to understand that a dissolved substance means the solute is uniformly distributed in the solvent and the individual particles are no longer visible as individual particles unless the solution is saturated; therefore, using a paper filter or screen will not separate the two substances.



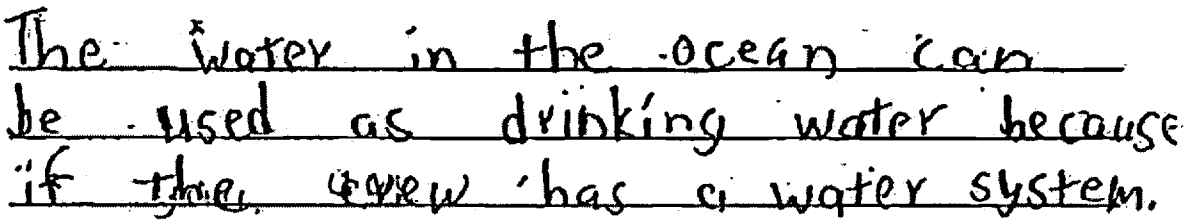
"They can collect ocean water and let the sun evaporate the salt from it." This response indicates one method of separating the solution using heat from the sun (evaporation) but does not describe a way to collect the water when it evaporates.

Score Point 0 – Inappropriate or incorrect response

The following two student responses received no points for their answers.



"By letting it sit in the sun." This response does not explain why this method will work. For minimal credit, the student would have to indicate that the sun would evaporate the water.



"The water in the ocean can be used as drinking water because if the crew has a water system." The response did not explain one way to separate the solution.

Earth in Space – Solar System Models

In the elementary years, students work with a simple solar system model (sun, earth, and moon) and observe patterns of stars in the sky. In the middle school years, children need experiences to develop a clear sense of the relative positions of the sun, the moon, and the earth. The study of the solar system is non-concrete; therefore, students need to build knowledge by using models and simulations. Students need to recognize that the planets and their moons are in regular and predictable motion resulting in predictable patterns such as day and night, the earth's year, and the phases of the moon. Students should also be able to explain the reason that Delaware experiences four seasons. In addition to reaching a fuller understanding of the solar system, middle school students extend their knowledge of the Sun as the major source of energy and investigate the Sun's light energy as it interacts with matter. Students need experiences to see that light travels in straight lines and that it is reflected, refracted, and absorbed when it encounters various materials. The following question requires students to integrate their knowledge of solar systems with their knowledge of matter and energy interactions.

Item #3—Solar System Models

This question measures student understanding of Solar System Models, under Earth in Space, Standard #4:

> ***"The apparent shape of the Moon changes dramatically as it moves in its orbit. These shapes, called phases, relate to lunar visibility and the times at which the Moon rises and sets. The Moon produces no light of its own and shines only as a result of sunlight reflected from its surface."***

Question:

Explain why the Moon appears to be shining when viewed from Earth at night. You may use labeled drawings as part of your answer.

Rubric:

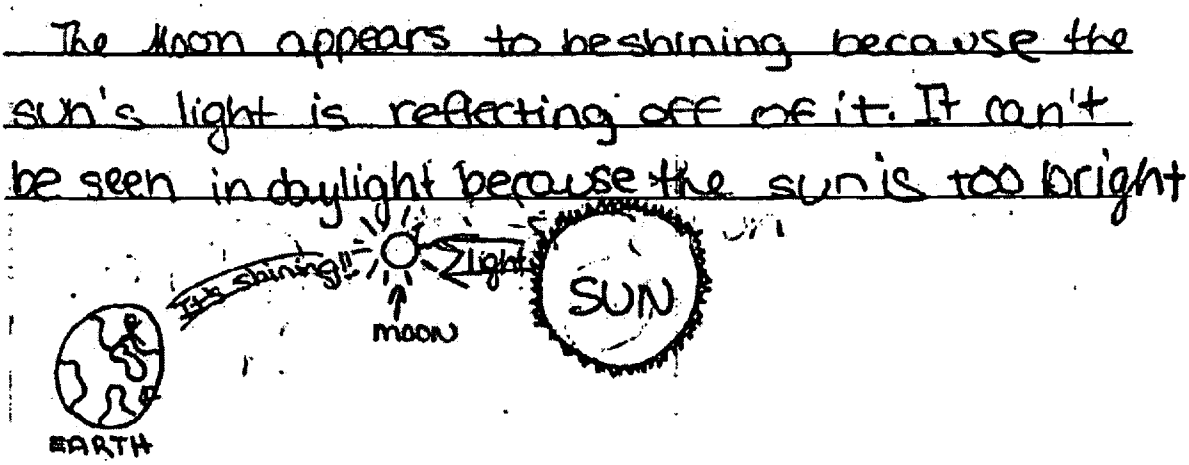
Score Point 2 – Student explains that the Moon reflects light from the Sun and the brightness of the Sun during the day prohibits clear visibility of the Moon.

Score Point 1 – Student responds that the Moon is seen better at night because there is no interference from the Sun.

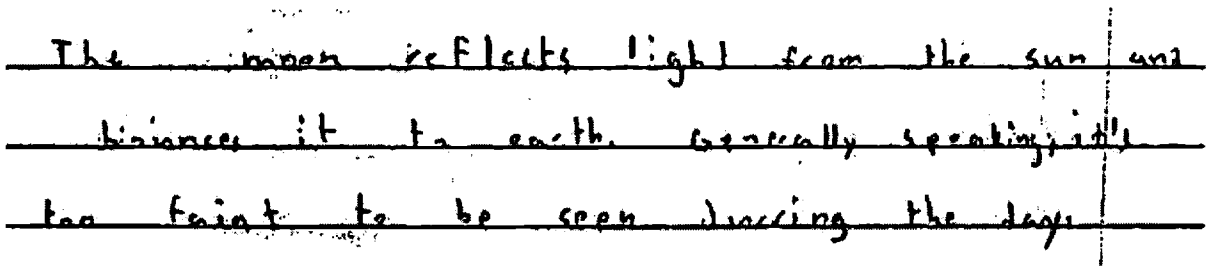
Score Point 0 – Inappropriate or no response.

Score Point 2 – Student explains that the Moon reflects light from the Sun and the brightness of the Sun during the day prohibits clear visibility of the Moon.

The following three student responses received two points for their answers.

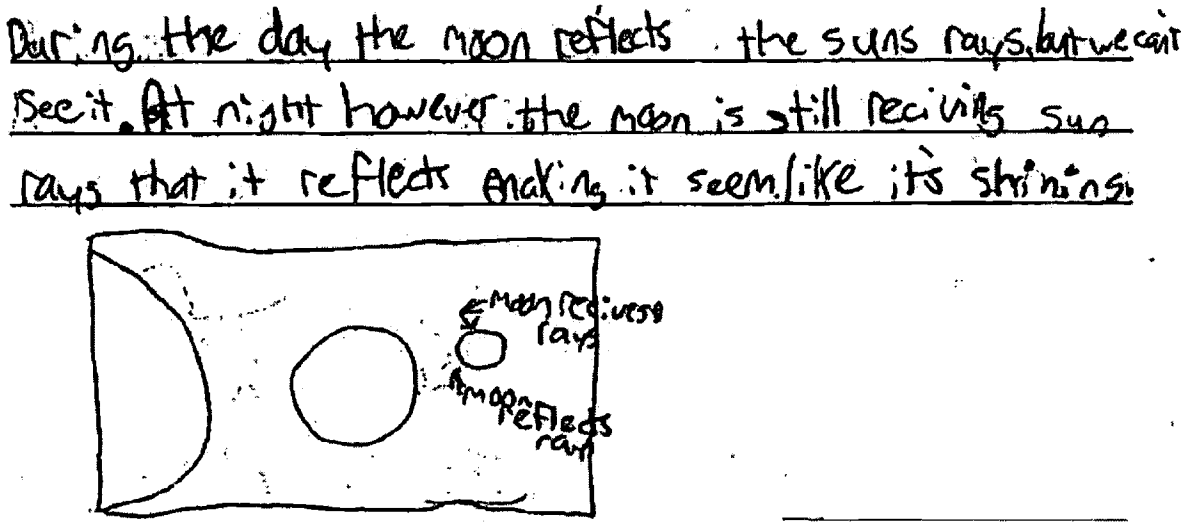


"The moon appears to be shining because the sun's light is reflecting off of it. It can't be seen in daylight because the sun is too bright." The response demonstrates an understanding that the moon's light is reflected light from the sun and that the brightness from the sun prevents it from being seen during the day.



"The moon reflects light from the sun and bounces it to earth. Generally speaking, it's too faint to be seen during the day." The student provides an understanding that the light from the moon is reflected from the sun and notes that the light from the moon is barely visible during the day—implying that the moon continues to reflect light even during daytime.

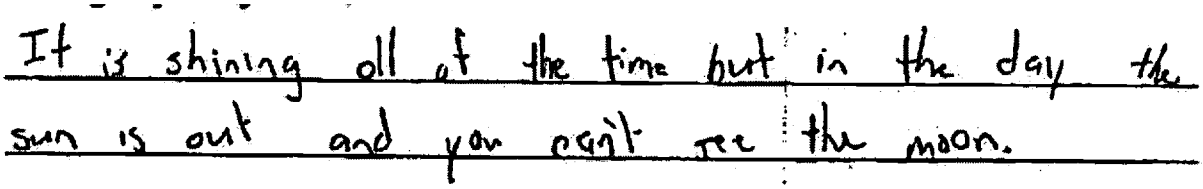
Score Point 2 – Student explains that the Moon reflects light from the Sun and the brightness of the Sun during the day prohibits clear visibility of the Moon.



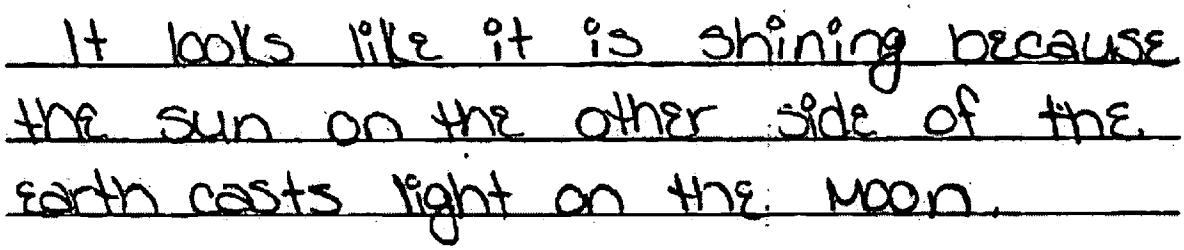
"During the day the moon reflects the suns (sic) rays, but we can't see it. At night however the moon is still reciving (sic) sun rays that it reflects making it seem like it's shining." In this response, the student indicates an understanding that the light from the moon is reflected light that occurs continually—both day and night—and states that it cannot be seen during the day.

Score Point 1 – Student responds that the Moon is seen better at night because there is no interference from the Sun.

The following three student responses received one point for their answers.



"It is shining all of the time but in the day the sun is out and you can't see the moon." The response earns one point for noting that the moon is shining both day and night and mentions the role of the sun in preventing the moon's light from being seen during the day. However, the student did not explain that the light from the moon is reflected light from the sun.



"It looks like it is shining because the sun on the other side of the earth casts light on the moon." The response indicates that the sun casts light on the moon but does not explain that the light is reflected—which enables it to be seen. Nor does the response address why the moon's light is not visible during the day.

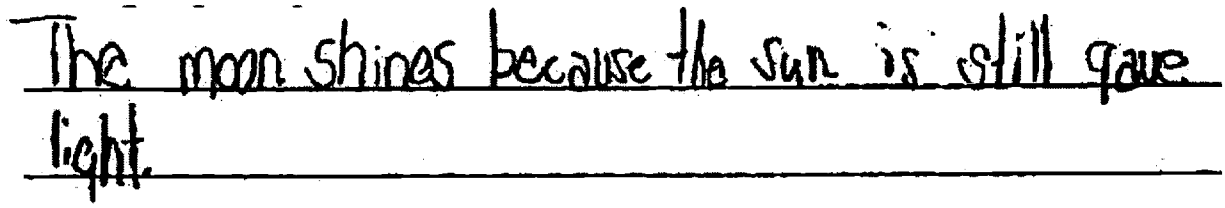
Score Point 1 – Student responds that the Moon is seen better at night because there is no interference from the Sun.

The moon appears to be shining at night because the sun shines light on it.

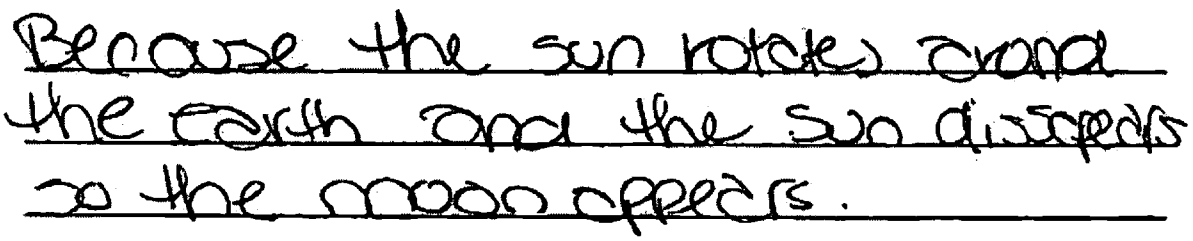
"The moon appears to be shining at night because the sun shines light on it." In this answer, the student notes that the sun's light shines on the moon but does not provide the reason that the light is seen from earth, i.e., that the light is reflected off the moon. Nor does the answer suggest any reason why the moon is not visible during the day.

Score Point 0 – Inappropriate or no response

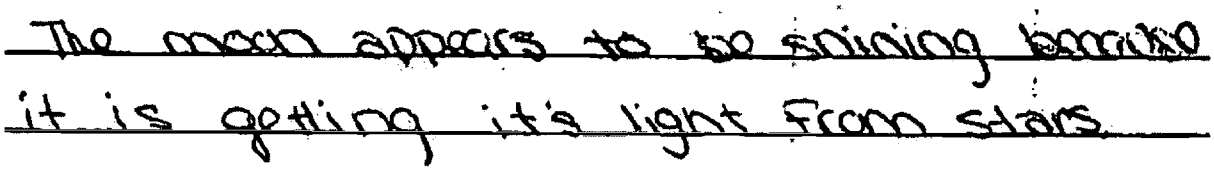
The following five student responses received no points for their answers.



"The moon shines because the sun is still gave (sic) light." In this response, the student does not clearly explain the relationship between the light from the sun and the shining of the moon.



"Because the sun rotates around the earth and the sun dissappears (sic) so the moon appears." This response manifests a major misconception that the sun is rotating around the earth rather than the other way around. It seems to suggest that the moon is its own source of light that is visible when the moon appears.



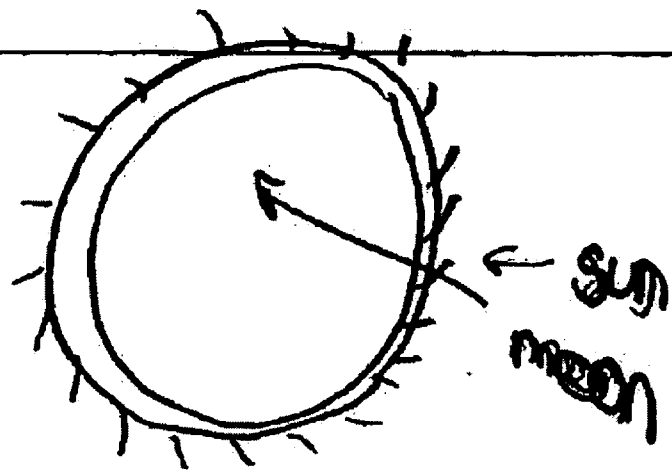
"The moon appears to be shining because it is getting it's (sic) light from stars." In this response, the student indicates a different source of confusion—that the light from the moon originates from other stars rather than from the sun. The response also reveals an incorrect model of the solar system, including the size of the sun, and the distances between the earth, moon, and other stars.

Score Point 0 – Inappropriate or no response

The moon might be like that because the moon is closer to earth than any other star.

"The moon might be like that because the moon is closer to earth than any other star." The response seems to suggest that the light from the moon is due to its proximity to earth. In addition, the student does not correctly explain the source and the reflection of the moon's light.

The sun might be behind the moon



"The sun might be behind the moon." In this response, the student has no conception that the moon's light is reflected light and instead attributes the shining moon to the sun that is located behind the moon. The student's drawing reveals a major misconception regarding the relative sizes and distance relationships between the earth, sun, and moon.

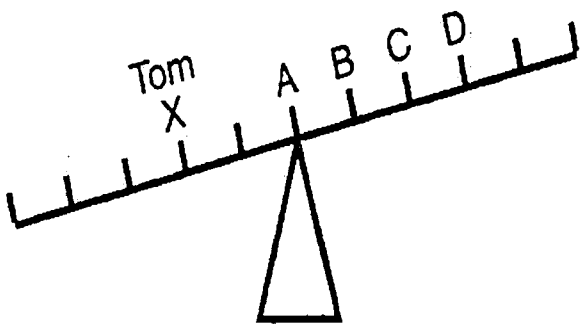
Energy and Its Effects – Force and Motion

Learning that pushes and pulls are simple forces begins in the elementary grades. Levers are also introduced and become more sophisticated at the middle school level. Students learn by experimentation that the distance between the fulcrum and the load affects the amount of effort required to lift the load. That is, the closer the load to the fulcrum, the less effort required to lift the load. In the item below, students must consider the load and the effort and their relative distances from a fixed fulcrum in order to answer the question.

Item #4 – Force and Motion

This question measures student understanding of Force and Motion, under Energy and Its Effects, Standard #3:

"Simple machines (e.g., levers, inclines, pulleys, gears) are used to change the force on an object and its speed or direction in order to make work easier."



Tom weighs 60 kg and is 2 m from the center of a seesaw. Gloria, who weighs 40 kg, sits on the seesaw across from Tom. In order to balance the seesaw, about where should Gloria sit?

a. A
b. B
c. C
d. D

Answer: d

Materials and Their Properties - Conservation of Matter

In grades 9-12, students continue to study the relationship between properties of matter and structure. Understanding this relationship requires that high school students develop the ability to relate the macroscopic properties of substances that they study in grades K-8 to the microscopic structure of substances (National Science Education Standards, 1996).

One of the big ideas that threads through the study of Materials and Their Properties is conservation of matter. In elementary grades, students learn that objects have observable properties many of which can be measured. They also develop an understanding that when objects undergo physical changes, the total amount of material in the object remains the same. In middle school, students' understanding of the conservation of matter continues as they observe and measure characteristic properties such as boiling points and melting points. They also learn that mass is conserved during phase changes.

During the high school years, as students begin to understand the basic structure of the atom, the reason why matter is neither created nor destroyed becomes more clear. However, given the abstract nature of atomic interactions, students need a wide variety of laboratory experiences to support their understanding of conservation of matter. Simply balancing a long list of equations does not provide the concrete links necessary for a thorough understanding of this important concept. The connection between the particles and the chemical formulas that represent them are often unclear to students. In addition, laboratory experiences such as dissolving and retrieving copper in an acid and comparing the mass of the metal dissolved with the metal retrieved will strengthen students' understanding of the conservation of matter.

Item #5—Conservation of Matter

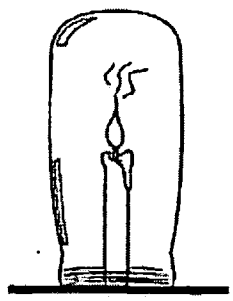
Students also need opportunities to investigate how substances interact in a closed system. That is, no matter how they combine or break apart, the total mass of the system remains the same. The following example of a burning candle in a closed system reveals a wide range of student understanding around conservation of mass in a closed system. Major misconceptions involving matter/energy interactions were obvious from student responses. For example, some students indicate that matter is transformed into heat energy. Other students believe that oxygen is "used up" by the burning candle and that matter is destroyed in burning.

The following item measures the Conservation of Matter strand under Materials and Their Properties, Standard #2:

> ***Regardless of how atoms and molecules in a closed system interact with one another, or how they combine or break apart, the total weight of the system remains the same.***

The question requires students to identify that the total mass of the burned substance will remain the same and provides a correct scientific reason for the unchanged total.

Question:



A candle is burned in a closed system. What happens to the total mass of this system as the candle burns and then goes out? Why?

Rubric:

Score Point 2 – The total mass is conserved (does not change) in a closed system. Student explains that nothing has been added or subtracted from the total initial amount of mass. Student may note that substances may have been changed chemically.

Score Point 1 – Student mentions that the mass is the same but no correct explanation is provided.

Score Point 0 – Off-task or inappropriate response.

Score Point 2 – The total mass is conserved (does not change) in a closed system. Student explains that nothing has been added or subtracted from the total initial amount of mass. Student may note that substances may have been changed chemically.

The following six student responses received two points for their answers.

The mass is the same because the law of the conservation of mass says that mass is neither created nor destroyed in a chemical reaction

"The mass is the same because the law of the conservation of mass says that mass is neither created nor destroyed in a chemical reaction." The student responded by identifying the correct total (the same) and providing a scientifically accurate reason by drawing upon the underlying principle, the Law of Conservation of Matter, as it applies to a closed system.

The mass will stay the same but it's form will change. You won't loose any thing because of the law of Conservation of matter.

"The mass will stay the same but it's (sic) form will change. You won't loose (sic) anything because of the law of conservation of matter." This correct response identified the total mass as unchanged and noted that matter had been transformed but there had been no loss of the total amount of matter.

Score Point 2 – The total mass is conserved (does not change) in a closed system. Student explains that nothing has been added or subtracted from the total initial amount of mass. Student may note that substances may have been changed chemically.

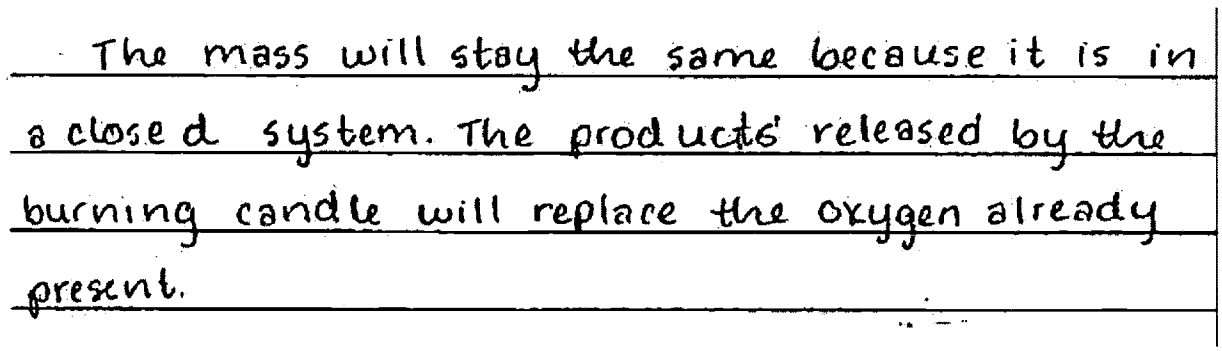
The total mass stays the same because the system is closed and mass cannot be created nor destroyed.

"The total mass stays the same because the system is closed and mass cannot be created nor destroyed." A third variation of a two point response met the criteria of a correct answer represented in the scoring tool, emphasizing the fact that the system is closed along with the principle of conservation of mass.

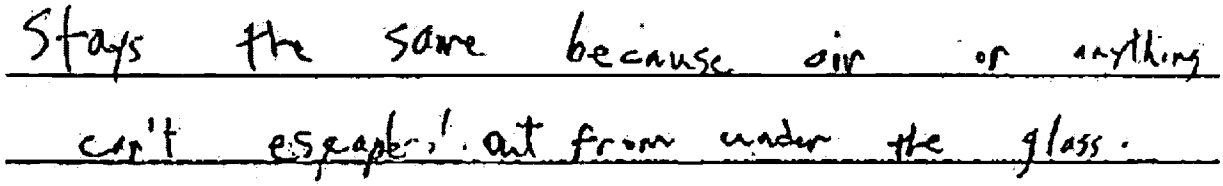
Stay the same because when the candle burns the gases are still in the glass so no mass is lossed until you lift the glass up

"Stay the same because when the candle burns the gases are still in the glass so no mass is lossed (sic) until you lift the glass." This response received two points for recognizing that the process is taking place in a closed system and that the total mass stays the same.

Score Point 2 – The total mass is conserved (does not change) in a closed system. Student explains that nothing has been added or subtracted from the total initial amount of mass. Student may note that substances may have been changed chemically.



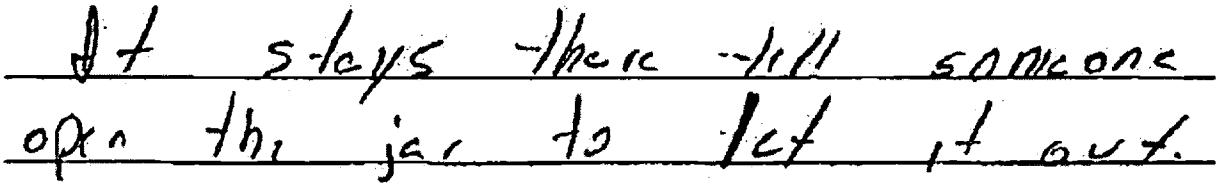
"The mass will stay the same because it is in a closed system. The products' (sic) released by the burning candle will replace the oxygen already present." This response received two points for recognizing that the process is taking place in a closed system and that the total mass stays the same.



"Stays the same because air or anything can't escape out from under the glass." According to this rubric, students could earn two points by indicating that the total amount of mass could remain constant and providing a reason in terms of a closed system.

Score Point 1 – Student mentions that the mass is the same but no correct explanation is provided.

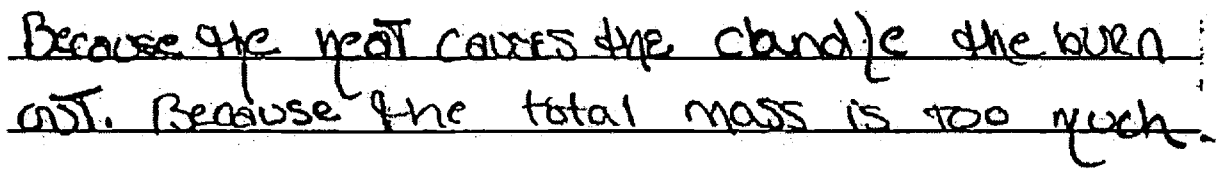
One point indicates that students had responded to part of the question correctly or had provided enough relevant information in response to the question.



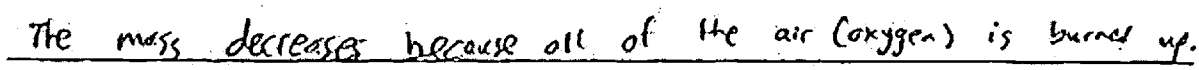
"It stays there till (sic) someone open (sic) the jar to let it out." This student's response provided a weak reason and did not state explicitly whether the total mass was the same or not.

Score Point 0 – Off-task or inappropriate response.

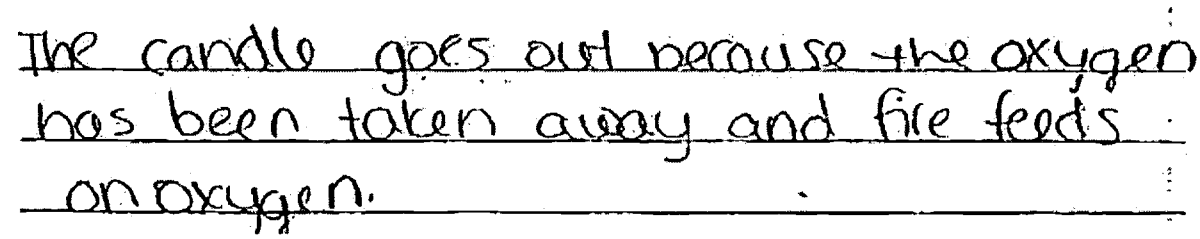
The following three student responses received no points. Incorrect responses are devoid of even correct knowledge in response to the question.



"Because the heat causes the candle the (sic) burn out. Because the total mass is too much."



"The mass decreases because all of the air (oxygen) is burned up."



"The candle goes out because the oxygen has been taken away and fire feeds on oxygen."

In the above student responses, students evidenced their misconceptions about chemical reactions, energy, and conservation of mass.

Diversity and Continuity of Living Things – Heredity

At the elementary level, students develop a foundational understanding of heredity by learning how offspring are similar to parents. At the middle school level, students study Mendelian genetics (including simple Punnett squares) and work with dominant and recessive traits. At the high school level, students need an understanding that, as no organism lives forever, reproduction is essential to the continuation of every species. Some organisms reproduce sexually; other reproduce asexually. Our students need to develop an understanding of the advantages of both processes of reproduction. Both processes preserve the unity of life while sexual reproduction (meiosis) contributes to the diversity of the gene pool and of organisms.

Item #6—Heredity

In high school, student understanding of genetics will expand by incorporating more abstract knowledge, such as the structure and function of DNA, which then allows an understanding of more comprehensive theories like evolution. At the high school level, students should be able to explain "heredity is the passage of the instructions for specifying traits from one generation to the next." The characteristics of an organism can be described in terms of a combination of traits. Some traits are inherited and others result from interactions with the environment." (National Science Education Standards, 1996). Delaware students have exhibited confusion in recognizing the relative scale as well as the difference between DNA molecules, genes, codons, chromosomes, and traits based on the following responses. This differentiation is critical to an understanding of how genetic information is transmitted from parents to offspring as the example below shows. The basic fact that DNA is in every living cell of every organism and that each chromosome is comprised of a single DNA molecule is a real source of confusion based on the following responses. "In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed from subunits of four kinds (A, G, C, and T)." (National Science Education Standards, 1996).

This question measures student understanding of Heredity, under the Diversity and Continuity of Living Things, Standard #7:

> ***Heredity/genetic information in chromosomes is contained in molecules of DNA that consist of various combinations of four different subunits (nucleotides) that encode this information. Genes are sections of DNA that direct syntheses of specific proteins associated with traits in organisms.***

Question:

Explain why a DNA molecule can be used to determine whether someone is or is not the parent of a particular child.

Rubric:

Score Point 2 – Student explanation includes the function of DNA, identifies the sequence of the nitrogen bases as the structural characteristic that allows every individual organism to have its own unique DNA. May or may not relate these characteristics to its use in criminal and paternity cases. Portions of an individual's DNA match to their parents.

Score Point 1 – Partially correct, e.g., student explains that every organism has its own unique DNA (student may indicate that this allows for criminal and paternal identification) but does not include any further explanation.

Score Point 0 – Incorrect, inappropriate, or incomplete response.

Score Point 2 – Student explanation includes the function of DNA, identifies the sequence of the nitrogen bases as the structural characteristic that allows every individual organism to have its own unique DNA. May or may not relate these characteristics to its use in criminal and paternity cases. Portions of an individual's DNA match to their parents.

The following responses received two points for their answers.

A DNA molecule is like a fingerprint with distinct traits. Because a child's DNA comes from both parents, specific genes would come from each parent. Those genes can be identified and used to determine if the child has the same genes.

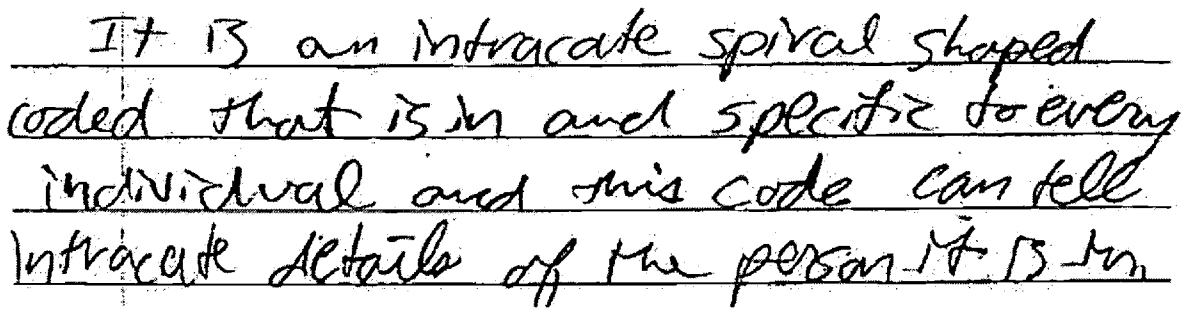
"A DNA molecule is like a fingerprint with distinct traits. Because a child's DNA comes from both parents, specific genes would come from each parent. Those genes can be identified and used to determine if the child has the same genes." This two point response shows an understanding of the DNA molecule that is transmitted from parents to offspring and conveys some understanding that parents pass on unique sequences of DNA to offspring.

When a child is born it has pieces of DNA from both parents. The DNA codes can be matched to that of the child's parents because DNA doesn't change. Therefore the parent of the child can be identified by having the same DNA.

"When a child is born it has pieces of DNA from both parents. The DNA codes can be matched to that of the child's parents because DNA doesn't change. Therefore the parent of the child can be identified by having the same DNA." This two point response shows an understanding of the DNA molecule that is transmitted from parents to offspring and conveys some understanding that parents pass on unique sequences of DNA to offspring.

Score Point 1 – Partially correct, e.g., student explains that every organism has its own unique DNA (student may indicate that this allows for criminal and paternal identification) but does not include any further explanation.

For one point, students needed to indicate some correct information that is a response to the question.



"It is an intracate (sic) spiral shaped coded (sic) that is in and specific to every individual and this code can tell intracate (sic) details of the person it is in." This response indicates some knowledge of molecular DNA (intricate spiral shape coded) and the awareness of the unique specificity to each individual. However, the response lacks an explicit connection between parents and offspring.

Score Point 0 – Incorrect, inappropriate, or incomplete response.

Incorrect student responses varied around their confusions about DNA, genes, chromosomes, and traits, such as the following demonstrate:

If the DNA of both parents shows SA which carries the sickle trait and the child is either SA or SS then that means that those are indeed the correct parents.

"If the DNA of both parents shows SA which carries the sickle trait and the child is either SA or SS then that means that those are indeed the correct parents."

The child and the parents will have similar DNA.

"The child and the parents will have similar DNA."

This is how you would figure out bloods types and match them to see the change or the same.

"This is how you would figure out bloods (sic) types and match them to see the change or the same."

Nature of Science and Technology – Science as Inquiry

Item #7—Experimental Design

At the elementary and middle school grades, students learn how to conduct simple investigations while manipulating one variable. High school students should develop sophistication in their abilities and understanding of inquiry by designing and carrying out investigations that are meaningful and closely approximate sound science. By being afforded these opportunities, students discover that if more than one variable changes at the same time in the investigation, the outcome of that investigation may not be clearly attributable to any one of the variables. Responses to the following item indicate the students are confused regarding appropriate experimental design including variables that are held constant, variables that are manipulated, and controls.

This question measures Science as Inquiry under the Nature and Application of Science and Technology, Standard #1:

> ***Scientific investigations in many cases follow no fixed set of steps. However, there are certain features of a valid scientific investigation that are essential and result in evidence that can be used to construct explanations.***

Question:

A farmer wants to compare his old fertilizer with a new fertilizer for growing soybeans. The farmer has a choice of testing his idea using three 20-acre plots in separate areas or one plot divided into three equal-sized sections. What should the farmer do to conduct a fair test? Explain why.

Rubric:

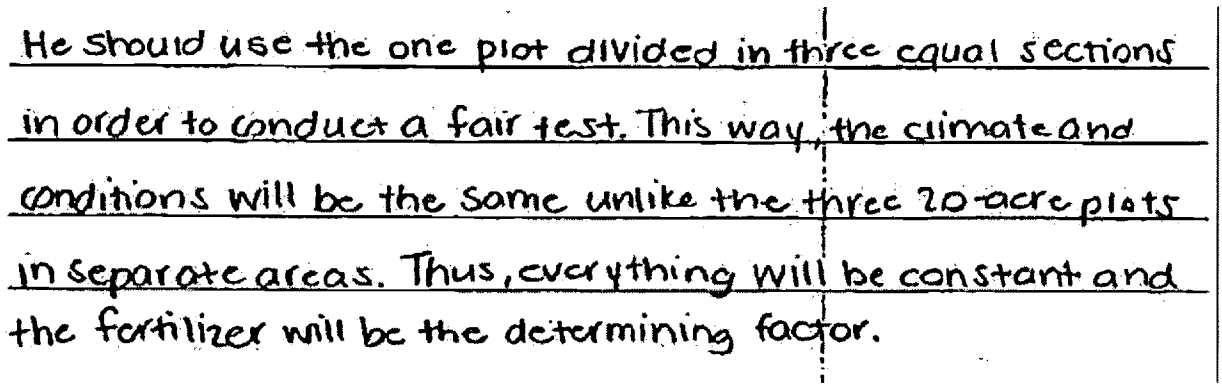
Score Point 2 – Use single plot to control variables (like drainage, soil type, and exposure to sunlight).

Score Point 1 – Use single plot to control variables or conditions. No elaboration.

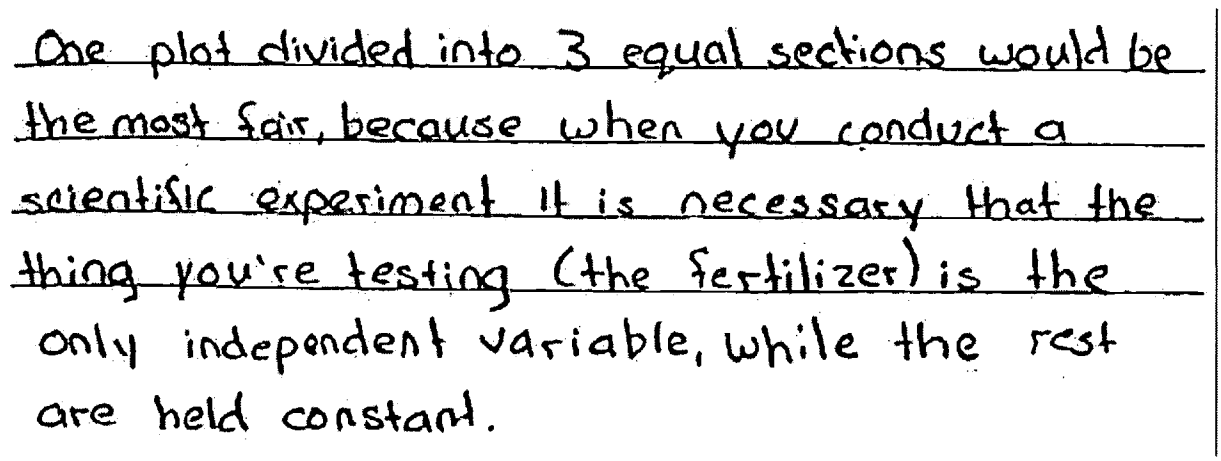
Score Point 0 – Incorrect, inappropriate, or incomplete response.

Score Point 2 – Use single plot to control variables (like drainage, soil type, and exposure to sunlight).

The following three student responses were given two points, because they demonstrate a fundamental grasp of controlling variables in order to ascertain the effect of the independent variable on the dependent variable.

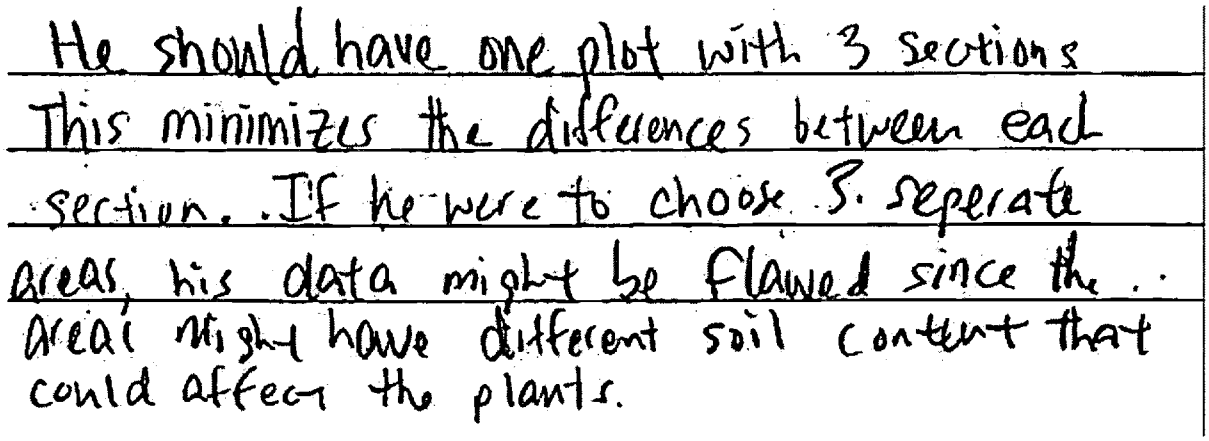

He should use the one plot divided in three equal sections in order to conduct a fair test. This way, the climate and conditions will be the same unlike the three 20-acre plots in separate areas. Thus, everything will be constant and the fertilizer will be the determining factor.

"He should use the one plot divided in three equal sections in order to conduct a fair test. This way, the climate and conditions will be the same unlike the three 20-acre plots in separate areas. Thus, everything will be constant and the fertilizer will be the determining factor."


One plot divided into 3 equal sections would be the most fair, because when you conduct a scientific experiment it is necessary that the thing you're testing (the fertilizer) is the only independent variable, while the rest are held constant.

"One plot divided into 3 equal sections would be the most fair, because when you conduct a scientific experiment it is necessary that the thing you're testing (the fertilizer) is the only independent variable, while the rest are held constant."

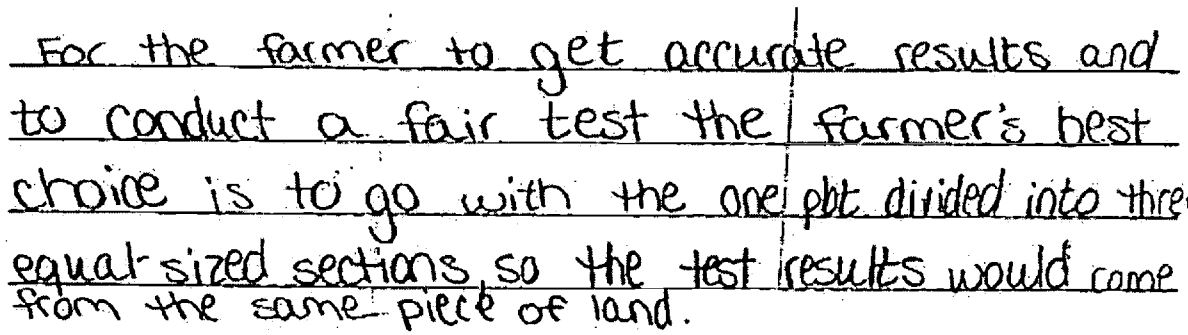
Score Point 2 – Use single plot to control variables (like drainage, soil type, and exposure to sunlight).



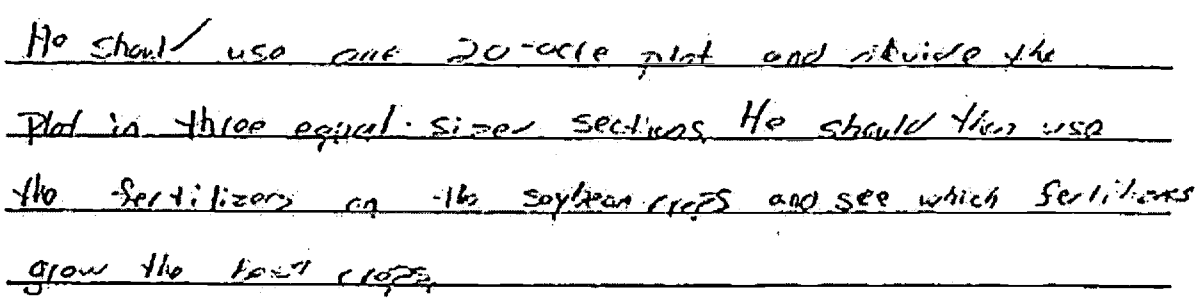
"He should have one plot with 3 sections. This minimizes the differences between each section. If he were to choose 3 separate areas, his data might be flawed since the areas might have different soil content that could affect the plants."

Score Point 1 – Use single plot to control variables or conditions. No elaboration.

The following two student responses were given one point for their answers.



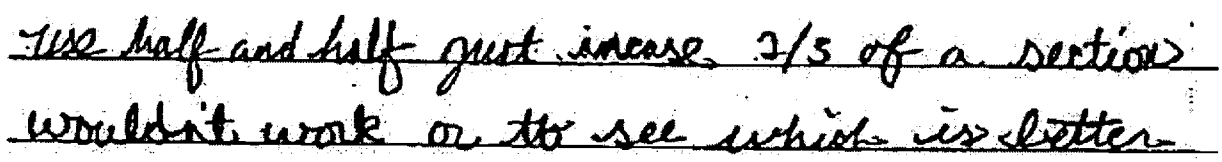
"For the farmer to get accurate results and to conduct a fair test the farmer's best choice is to go with the one plot divided into three equal-sized sections, so the test results would come from the same piece of land." This response identifies an important variable to control but explains the reason for controlling the land in terms of the source of the results ("same piece of land"), rather than in terms of the need to have accurate results that have not been affected by some other variable(s).



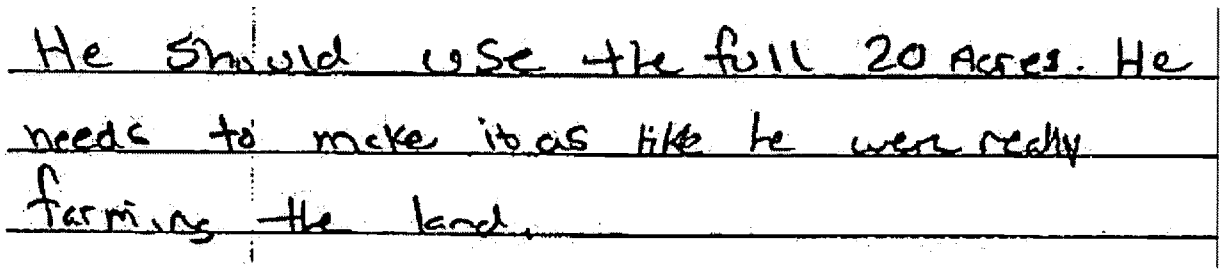
"He should use one 20-acre plot and divide the plot in three equal-sized sections. He should then use the fertilizers on the soybean crops and see which fertilizers grow the best crops." The response earned one point for identifying a correct variable to control (20 acre plot in three equal sections) but provided no reason why it is important to control variables that could affect the results of an investigation.

Score Point 0 – Incorrect, inappropriate, or incomplete response.

The following two student responses received no points.



"Use half and half just incase (sic) 2/3 of a section wouldn't work or to see which is better."
This response exhibited no knowledge of experimental design.



"He should use the full 20 acres. He needs to make it as like he were really farming the land."
This response exhibited no knowledge of experimental design.

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