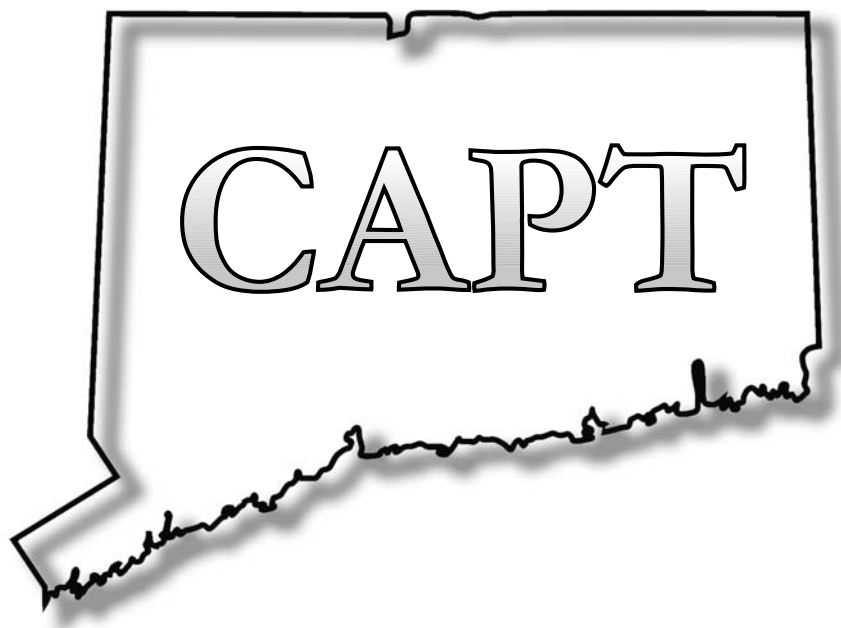


**CAPT Science
2010 Administration**



**Released Items and
Scored Student Responses**

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CAPT Science Framework

The CAPT Science was developed with the input of Connecticut educators and reflects a growing national consensus that science is not only a body of knowledge, but also a way of thinking about the world around us and a concern for how that knowledge is used. The Science test assesses students' understanding of important scientific concepts, as well as their application of those concepts to realistic problems. In addition, experimentation and the ability to use scientific reasoning to solve problems are a major focus of the test.

To align with the Science Curriculum Framework, the following content strands are reported:

- Energy Transformations
- Chemical Structures and Properties
- Global Interdependence
- Cell Chemistry and Biotechnology
- Genetics, Evolution, and Biodiversity

In addition, scores are reported for the following:

- Conceptual Understanding
- Scientific Inquiry, Literacy, and Numeracy

Students respond to 60 multiple-choice (MC) and 5 open-ended (OE) items. The test is divided into two 50-minute sessions.

| CAPT Science | Content Knowledge | Scientific Inquiry, Literacy and Numeracy | | |
|--|--------------------|---|---------------------|------------------|
| Content Strand | MC Items (1 point) | MC Items (1 point) | OE Items (3 points) | Points |
| I. Energy Transformations | 8 | 4 | 1 | 15 |
| II. Chemical Structures & Properties | 8 | 4 | 1 | 15 |
| III. Global Interdependence | 8 | 4 | 1 | 15 |
| IV. Cell Chemistry & Biotechnology | 8 | 4 | 1 | 15 |
| V. Genetics, Evolution & Biodiversity | 8 | 4 | 1 | 15 |
| Totals | 40 MC Items | 20 MC Items | 5 OE Items | 75 Points |

Students respond to two different types of items: multiple-choice and open-ended. On the open-ended items, students are asked to respond in writing to the question, or they may be asked to sketch a graph. Multiple-choice items are scored electronically as correct or incorrect. Open-ended items are hand-scored using a 4-point holistic rubric (0–3). Scientific Inquiry, Literacy, and Numeracy expected performances are tested using both multiple-choice and open-ended items.

A state goal standard has been set for the Science test. Students who reach the state goal receive a Certificate of Mastery in Science.

A curriculum-embedded science performance task has been developed for each of the five content strands. These tasks will be utilized for the entire third generation of the test. Schools are encouraged to embed these tasks into their regular grade 9 and 10 science curricula at the appropriate time. All of the open-ended items on the written test are related to the five tasks.

Core Science Curriculum Framework for Grades 9 and 10

THE STANDARDS FOR SCIENTIFIC INQUIRY, LITERACY, AND NUMERACY ARE INTEGRAL PARTS OF THE CONTENT STANDARDS FOR EACH GRADE LEVEL IN THIS CLUSTER.

| Grades 9–10 Core Scientific Inquiry, Literacy, and Numeracy | |
|--|---|
| <i>How is scientific knowledge created and communicated?</i> | |
| Content Standards | Expected Performances |
| <p>SCIENTIFIC INQUIRY</p> <ul style="list-style-type: none"> ◆ Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain, and predict natural phenomena. ◆ Scientific inquiry progresses through a continuous process of questioning, data collection, analysis, and interpretation. ◆ Scientific inquiry requires the sharing of findings and ideas for critical review by colleagues and other scientists. <p>SCIENTIFIC LITERACY</p> <ul style="list-style-type: none"> ◆ Scientific literacy includes the ability to read, write, discuss, and present coherent ideas about science. ◆ Scientific literacy also includes the ability to search for and assess the relevance and credibility of scientific information found in various print and electronic media. <p>SCIENTIFIC NUMERACY</p> <ul style="list-style-type: none"> ◆ Scientific numeracy includes the ability to use mathematical operations and procedures to calculate, analyze, and present scientific data and ideas. | <p>D INQ.1 Identify questions that can be answered through scientific investigation.</p> <p>D INQ.2 Read, interpret, and examine the credibility and validity of scientific claims in different sources of information.</p> <p>D INQ.3 Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.</p> <p>D INQ.4 Design and conduct appropriate types of scientific investigations to answer different questions.</p> <p>D INQ.5 Identify independent and dependent variables, including those that are kept constant and those used as controls.</p> <p>D INQ.6 Use appropriate tools and techniques to make observations and gather data.</p> <p>D INQ.7 Assess the reliability of the data that was generated in the investigation.</p> <p>D INQ.8 Use mathematical operations to analyze and interpret data, and present relationships between variables in appropriate forms.</p> <p>D INQ.9 Articulate conclusions and explanations based on research data, and assess results based on the design of the investigation.</p> <p>D INQ.10 Communicate about science in different formats, using relevant science vocabulary, supporting evidence, and clear logic.</p> |

Grade 9

Core Themes, Content Standards and Expected Performances

Strand I: Energy Transformations

| Content Standards | Expected Performances |
|---|---|
| <p><i>Energy Transfer and Transformations – What is the role of energy in our world?</i></p> <p>9.1 - Energy cannot be created or destroyed; however, energy can be converted from one form to another.</p> <ul style="list-style-type: none"> ◆ Energy enters the Earth system primarily as solar radiation, is captured by materials and photosynthetic processes, and eventually is transformed into heat. | <p>D 1. Describe the effects of adding energy to matter in terms of the motion of atoms and molecules, and the resulting phase changes.</p> <p>D 2. Explain how energy is transferred by conduction, convection, and radiation.</p> <p>D 3. Describe energy transformations among heat, light, electricity, and motion.</p> |
| <p><i>Energy Transfer and Transformations – What is the role of energy in our world?</i></p> <p>9.2 - The electrical force is a universal force that exists between any two charged objects.</p> <ul style="list-style-type: none"> ◆ Moving electrical charges produce magnetic forces, and moving magnets can produce electrical force. ◆ Electrical current can be transformed into light through the excitation of electrons. | <p>D 4. Explain the relationship among voltage, current, and resistance in a simple series circuit.</p> <p>D 5. Explain how electricity is used to produce heat and light in incandescent bulbs and heating elements.</p> <p>D 6. Describe the relationship between current and magnetism.</p> |
| <p><i>Science and Technology in Society – How do science and technology affect the quality of our lives?</i></p> <p>9.3 - Various sources of energy are used by humans and all have advantages and disadvantages.</p> <ul style="list-style-type: none"> ◆ During the burning of fossil fuels, stored chemical energy is converted to electrical energy through heat transfer processes. ◆ In nuclear fission, matter is transformed directly into energy in a process that is several million times as energetic as chemical burning. ◆ Alternative energy sources are being explored and used to address the disadvantages of using fossil and nuclear fuels. | <p>D 7. Explain how heat is used to generate electricity.</p> <p>D 8. Describe the availability, current uses, and environmental issues related to the use of fossil and nuclear fuels to produce electricity.</p> <p>D 9. Describe the availability, current uses, and environmental issues related to the use of hydrogen fuel cells, wind, and solar energy to produce electricity.</p> |

Grade 9

Core Themes, Content Standards and Expected Performances

Strand II: Chemical Structures and Properties

| Content Standards | Expected Performances |
|---|---|
| <p><i>Properties of Matter – How does the structure of matter affect the properties and uses of materials?</i></p> <p>9.4 - Atoms react with one another to form new molecules.</p> <ul style="list-style-type: none"> ◆ Atoms have a positively charged nucleus surrounded by negatively charged electrons. ◆ The configuration of atoms and molecules determines the properties of the materials. | <p>D 10. Describe the general structure of the atom, and explain how the properties of the first 20 elements in the Periodic Table are related to their atomic structures.</p> <p>D 11. Describe how atoms combine to form new substances by transferring electrons (ionic bonding) or sharing electrons (covalent bonding).</p> <p>D 12. Explain the chemical composition of acids and bases, and explain the change of pH in neutralization reactions.</p> |
| <p><i>Properties of Matter – How does the structure of matter affect the properties and uses of materials?</i></p> <p>9.5 - Due to its unique chemical structure, carbon forms many organic and inorganic compounds.</p> <ul style="list-style-type: none"> ◆ Carbon atoms can bond to one another in chains, rings and branching networks to form a variety of structures, including fossil fuels, synthetic polymers, and the large molecules of life. | <p>D 13. Explain how the structure of the carbon atom affects the type of bonds it forms in organic and inorganic molecules.</p> <p>D 14. Describe combustion reactions of hydrocarbons and their resulting by-products.</p> <p>D 15. Explain the general formation and structure of carbon-based polymers, including synthetic polymers, such as polyethylene, and biopolymers, such as carbohydrate.</p> |
| <p><i>Science and Technology in Society – How do science and technology affect the quality of our lives?</i></p> <p>9.6 - Chemical technologies present both risks and benefits to the health and well-being of humans, plants and animals.</p> <ul style="list-style-type: none"> ◆ Materials produced from the cracking of petroleum are the starting points for the production of many synthetic compounds. ◆ The products of chemical technologies include synthetic fibers, pharmaceuticals, plastics, and fuels. | <p>D 16. Explain how simple chemical monomers can be combined to create linear, branched, and/or cross-linked polymers.</p> <p>D 17. Explain how the chemical structure of polymers affects their physical properties.</p> <p>D 18. Explain the short- and long-term impacts of landfills and incineration of waste materials on the quality of the environment.</p> |

Grade 9

Core Themes, Content Standards and Expected Performances

Strand III: Global Interdependence

| Content Standards | Expected Performances |
|--|---|
| <p><i>The Changing Earth – How do materials cycle through the Earth’s systems?</i></p> <p>9.7 - Elements on Earth move among reservoirs in the solid earth, oceans, atmosphere, and organisms as part of biogeochemical cycles.</p> <ul style="list-style-type: none"> ◆ Elements on Earth exist in essentially fixed amounts and are located in various chemical reservoirs. ◆ The cyclical movement of matter between reservoirs is driven by the Earth’s internal and external sources of energy. | <p>D 19. Explain how chemical and physical processes cause carbon to cycle through the major earth reservoirs.</p> <p>D 20. Explain how solar energy causes water to cycle through the major earth reservoirs.</p> <p>D 21. Explain how internal energy of the Earth causes matter to cycle through the magma and the solid earth.</p> |
| <p><i>Science and Technology in Society – How do science and technology affect the quality of our lives?</i></p> <p>9.8 - The use of resources by human populations may affect the quality of the environment.</p> <ul style="list-style-type: none"> ◆ Emission of combustion by-products, such as SO₂, CO₂, and NO_x by industries and vehicles is a major source of air pollution. ◆ Accumulation of metal and non-metal ions used to increase agricultural productivity is a major source of water pollution. | <p>D 22. Explain how the release of sulfur dioxide (SO₂) into the atmosphere can form acid rain, and how acid rain affects water sources, organisms, and human-made structures.</p> <p>D 23. Explain how the accumulation of carbon dioxide (CO₂) in the atmosphere increases Earth’s “greenhouse” effect and may cause climate changes.</p> <p>D 24. Explain how the accumulation of mercury, phosphates, and nitrates affects the quality of water and the organisms that live in rivers, lakes, and oceans.</p> |
| <p><i>Science and Technology in Society – How do science and technology affect the quality of our lives?</i></p> <p>9.9 - Some materials can be recycled, but others accumulate in the environment and may affect the balance of the Earth systems.</p> <ul style="list-style-type: none"> ◆ New technologies and changes in lifestyle can have positive and/or negative effects on the environment. | <p>D 25. Explain how land development, transportation options, and consumption of resources may affect the environment.</p> <p>D 26. Describe human efforts to reduce the consumption of raw materials and improve air and water quality.</p> |

Grade 10

Core Themes, Content Standards and Expected Performances

Strand IV: Cell Chemistry and Biotechnology

| Content Standards | Expected Performances |
|--|---|
| <p><i>Structure and Function – How are organisms structured to ensure efficiency and survival?</i></p> <p>10.1 - Fundamental life processes depend on the physical structure and the chemical activities of the cell.</p> <ul style="list-style-type: none"> ◆ Most of the chemical activities of the cell are catalyzed by enzymes that function only in a narrow range of temperature and acidity conditions. ◆ The cellular processes of photosynthesis and respiration involve transformation of matter and energy. | <p>D 27. Describe significant similarities and differences in the basic structure of plant and animal cells.</p> <p>D 28. Describe the general role of DNA and RNA in protein synthesis.</p> <p>D 29. Describe the general role of enzymes in metabolic cell processes.</p> <p>D 30. Explain the role of the cell membrane in supporting cell functions.</p> |
| <p><i>Science and Technology in Society – How do science and technology affect the quality of our lives?</i></p> <p>10.2 - Microorganisms have an essential role in life processes and cycles on Earth.</p> <ul style="list-style-type: none"> ◆ Understanding the growth and spread patterns of viruses and bacteria enables the development of methods to prevent and treat infectious diseases. | <p>D 31. Describe the similarities and differences between bacteria and viruses.</p> <p>D 32. Describe how bacterial and viral infectious diseases are transmitted, and explain the roles of sanitation, vaccination, and antibiotic medications in the prevention and treatment of infectious diseases.</p> <p>D 33. Explain how bacteria and yeasts are used to produce foods for human consumption.</p> |
| <p><i>Science and Technology in Society – How do science and technology affect the quality of our lives?</i></p> <p>10.3 - Similarities in the chemical and structural properties of DNA in all living organisms allow the transfer of genes from one organism to another.</p> <ul style="list-style-type: none"> ◆ The principles of genetics and cellular chemistry can be used to produce new foods and medicines in biotechnological processes. | <p>D 34. Describe, in general terms, how the genetic information of organisms can be altered to make them produce new materials.</p> <p>D 35. Explain the risks and benefits of altering the genetic composition and cell products of existing organisms.</p> |

Grade 10

Core Themes, Content Standards and Expected Performances

Strand V: Genetics, Evolution and Biodiversity

| Content Standards | Expected Performances |
|---|---|
| <p><i>Heredity and Evolution – What processes are responsible for life’s unity and diversity?</i></p> <p>10.4 - In sexually reproducing organisms, each offspring contains a mix of characteristics inherited from both parents.</p> <ul style="list-style-type: none"> ◆ Genetic information is stored in genes that are located on chromosomes inside the cell nucleus. ◆ Most organisms have two genes for each trait, one on each of the homologous chromosomes in the cell nucleus. | <p>D 36. Explain how meiosis contributes to the genetic variability of organisms.</p> <p>D 37. Use the Punnet Square technique to predict the distribution of traits in mono- and di-hybrid crossings.</p> <p>D 38. Deduce the probable mode of inheritance of traits (e.g., recessive/dominant, sex-linked) from pedigree diagrams showing phenotypes.</p> <p>D 39. Describe the difference between genetic disorders and infectious diseases.</p> |
| <p><i>Heredity and Evolution – What processes are responsible for life’s unity and diversity?</i></p> <p>10.5 - Evolution and biodiversity are the result of genetic changes that occur over time in constantly changing environments.</p> <ul style="list-style-type: none"> ◆ Mutations and recombination of genes create genetic variability in populations. ◆ Changes in the environment may result in the selection of organisms that are better able to survive and reproduce. | <p>D 40. Explain how the processes of genetic mutation and natural selection are related to the evolution of species.</p> <p>D 41. Explain how the current theory of evolution provides a scientific explanation for fossil records of ancient life forms.</p> <p>D 42. Describe how structural and behavioral adaptations increase the chances for organisms to survive in their environments.</p> |
| <p><i>Science and Technology in Society – How do science and technology affect the quality of our lives?</i></p> <p>10.6 - Living organisms have the capability of producing populations of unlimited size, but the environment can support only a limited number of individuals from each species.</p> <ul style="list-style-type: none"> ◆ Human populations grow due to advances in agriculture, medicine, construction, and the use of energy. ◆ Humans modify ecosystems as a result of rapid population growth, use of technology, and consumption of resources. | <p>D 43. Describe the factors that affect the carrying capacity of the environment.</p> <p>D 44. Explain how change in population density is affected by emigration, immigration, birth rate and death rate, and relate these factors to the exponential growth of human populations.</p> <p>D 45. Explain how technological advances have affected the size and growth rate of human populations throughout history.</p> |

Items Found in This Packet

Open-Ended Items

Open-ended items are those for which a student must write a short response to a question. Included in this packet are the five open-ended items corresponding to the curriculum-embedded performance tasks.

CSDE has developed a suggested performance task for each of the five content strands in the science framework for Grades 9–10. Teachers are encouraged to use these tasks in the normal course of instruction when teaching the related content strand. The five constructed response items on the CAPT will assess scientific inquiry, literacy and numeracy using the context of the curriculum embedded tasks. These constructed response items total 15 points or 20 percent of the total test.

CAPT open-ended items are scored on a four-point scale (0–3) using a holistic scoring method. This method involves judging the overall quality of the student response. The general scoring rubric for the science open-ended items (see following page) describes the characteristics of a response at each score point. Included with each item is the content guide (description of a good response to the question), the specific scoring rubric for the item (description of each score point), and the classification of the item based on the CAPT Science Framework. This is followed by two scored student responses at each score point along with a brief discussion of why the response received a particular score.

Keep in mind that the scoring criteria are based on reasonable expectations of grade ten students responding under testing conditions. Students are given approximately five minutes to respond to each open-ended item. The responses are therefore less polished than they might be if students were given more time to revise their answers. In addition, students are asked to respond to a wide variety of scientific topics, many of which they may not have studied for some time. All of this is taken into consideration when scoring the responses.

Multiple-Choice Items

For each of the five content strands, eight multiple-choice items assess content knowledge and four multiple-choice items assess scientific inquiry, literacy, and numeracy skills. The entire Science test includes 60 multiple-choice items.

To foster depth of understanding, most CAPT multiple-choice items are organized in clusters related to particular scenarios. In addition, some clusters include specific information at the beginning which students can use in answering the questions. To stress the interdisciplinary nature of science, some clusters make connections between concepts of the major content areas.

Scoring Rubric for Science Open-Ended Items

Each score category contains a range of student responses which reflect the descriptions given below.

Score 3

The response is an excellent answer to the question. It is correct, complete, and appropriate and contains elaboration, extension, and/or evidence of higher-order thinking and relevant prior knowledge. There is no evidence of misconceptions. Minor errors will not necessarily lower the score.

Score 2

The response is a proficient answer to the question. It is generally correct, complete, and appropriate, although minor inaccuracies may appear. There may be limited evidence of elaboration, extension, higher-order thinking, and relevant prior knowledge, or there may be significant evidence of these traits but other flaws (e.g., inaccuracies, omissions, inappropriateness) may be more than minor.

Score 1

The response is a marginal answer to the question. While it may contain some elements of a proficient response, it is inaccurate, incomplete and/or inappropriate. There is little if any evidence of elaboration, extension, higher-order thinking, or relevant prior knowledge. There may be evidence of significant misconceptions.

Score 0

The response, although on topic, is an unsatisfactory answer to the question. It may fail to address the question, or it may address the question in a very limited way. There may be no evidence of elaboration, extension, higher-order thinking, or relevant prior knowledge. There may be evidence of serious misconceptions.

CAPT Science Open-Ended Item: *Acid Rain Investigation*

Acid Rain Investigation

A group of students wrote the following procedure for their acid rain investigation.

Procedure:

1. Find the mass of each of three different building materials being tested.
2. Pour 200 mL of acidified water, pH 4.5, into each of three clean containers.
3. Place each sample of building material into one of the three containers.
4. After two days, remove the samples, wash them with distilled water, and allow them to dry completely.
5. Mass each sample.

The chart below shows the students' investigation results.

| Material | Starting Mass (g) | Ending Mass (g) | Difference in Mass (g) | Percent Loss |
|-----------|-------------------|-----------------|------------------------|--------------|
| Granite | 6.2 | 6.2 | 0.0 | 0.0 |
| Marble | 8.7 | 8.1 | 0.6 | 6.9 |
| Limestone | 5.3 | 4.1 | 1.2 | 22.6 |

- a) What was the problem the students were investigating?
- b) Describe two things the students could do to increase confidence in their results.

Write your answer in your answer booklet.

Rubric for *Acid Rain Investigation*

Possible Correct Responses:

Possible Problem:

- How does acid rain affect the mass of different building materials?
- What type of building material holds up best in acid rain conditions?
- What is the best type of building material to use outdoors?
- What type of building material will degrade most quickly in acid rain conditions?
- Other reasonable questions/problems

Increase Confidence:

- perform additional trials using the same building materials
- add a control to their investigation
- perform additional trials using water with different acidities
- use samples that have the same surface area/same amount of material
- use samples that have the same starting mass
- let the samples sit in vinegar for a longer amount of time
- make sure the temperature of the solvent is held constant for each sample
- other acceptable responses

3-Point Rubric:

Score 3

The response describes a problem that could be investigated based on the procedure and data and describes two things the students could do to increase confidence in their results.

Score 2

The response provides a problem that could be investigated based on the procedure and data and describes one thing the students could do to increase confidence in their results.

-or-

The response describes two things the students could do to increase confidence in their results, but fails to or incorrectly describes a problem.

Score 1

The response describes a problem that could be investigated based on the procedure and data, but fails to or incorrectly describes two things the students could do to increase confidence in their results.

-or-

The response describes one thing the students could do to increase confidence in their results, but fails to or incorrectly describes a problem.

Score 0

The response provides little or no correct information.

Strand III: Global Interdependence

Expected Performance: D INQ.3 Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.

Scored Student Responses for Acid Rain Investigation

Score 3

a. WHICH ROCK ERODED THE MOST
WHEN IN CONTACT W/ ACIDIC WATER

b. THEY COULD REPEAT THE EXPERIMENT
AND THEY COULD GET 3 SAMPLES W/
THE SAME STARTING MASS.

This response provides a valid problem that could be investigated based on the procedure and data: "Which rock eroded the most when in contact w/ acidic water." Two correct and specifically described things the students could do to increase confidence in their results are given: "They could repeat the experiment [sic] and they could get 3 samples w/ the same starting mass."

Scored Student Responses for *Acid Rain Investigation*

Score 3

a) The problem is to see which building material losses the most mass when put into acidified water.

b) To increase confidence in their results, the student could have done more trials and make sure that all of their materials are clean.

This response provides a valid problem that could be investigated based on the procedure and data: "...to see which building material losses [sic] the most mass when put into acidified water." The response also describes two appropriate things the students could do to increase confidence in their results: "...the student could have done more trials and make sure that all of their materials are clean."

Scored Student Responses for Acid Rain Investigation

Score 2

- a.) Which building material does acidified water have the most destructive effect on?
- b.) First, they should have a control, which would just be plain water, to compare results with. Secondly, they should try to record once every five hours or so, to gain a better understanding of how quickly the acid rain is effecting each material.

This response provides a valid problem that could be investigated based on the procedure and data: "Which building material does acidified water have the most destructive effect on?" One correct and specifically described thing the students could do to increase confidence in their results is given: "...they should have a control, which would just be plain water, to compare results with." This experiment is measuring the cumulative effect of acid rain rather than an hourly effect; therefore, the suggestion to "record once every five hours or so" is not acceptable.

Scored Student Responses for *Acid Rain Investigation*

Score 2

The students were investigating how much acid rain would be absorbed into granite, marble, or limestone.

Two things the students can do to increase confidence in their results is to attempt more trials and place them all under the same weather and atmosphere.

This response fails to provide a valid problem that could be investigated based on the procedure and data. The students were not investigating how much the materials absorbed, but rather how much they were eroded. However, the response describes two appropriate things the students could do to increase confidence in their results: "...attempt more trials and place them all under the same weather and atmosphere."

Scored Student Responses for *Acid Rain Investigation*

Score 1

a) the problem the students were investigating was how long building materials would last before needing to be replaced under conditions like acid rain.

b) They could list the ratio of water to acid in their data. The students could also list what kind of container they put ~~the~~ the acid material in to see if that affected or measured results

This response provides a valid problem that could be investigated based on the procedure and data: "...How long Building materials would last Before needing to Be replaced under conditions like acid rain." Simply listing what information should be reported in the given procedure (water to acid ratios and types of containers used) would not increase confidence in their results.

Scored Student Responses for *Acid Rain Investigation*

Score 1

The problem is that they didn't specify what materials we SHOULD use in the investigation, they just said 3 different building materials. One thing the students could do to increase the results is that they could get the 3 certain types of building materials. Also they should start the mass of each material as the same. Starting at different ones makes the results not be as helpful as they should be.

The response offers a perceived problem with this investigation (“...they didn’t specify what materials we SHOULD use...”) rather than providing a valid problem that could be investigated based on the procedure and data. However, one appropriately described thing the students could do to increase confidence in their results is given: “...they should start the mass of each material as the same.”

Scored Student Responses for *Acid Rain Investigation*

Score 0

The problem the students were investigating is which material has a better mass. And how are the materials different.

The students could add what time they started, and what time they finish.

This response fails to provide a valid explanation for the problem being investigated. Students were not trying to find which material has a better mass, but rather the effect acidified water had on the materials. Simply listing what information should be reported in the given procedure (starting time and ending time) would not increase confidence in their results.

Scored Student Responses for *Acid Rain Investigation*

Score 0

(a) The problem was how much mass is in Granite, Marble, and Lime stone. (b) They could have found the average mass and they could have been specific on how long they let ~~them~~ the materials dry for.

This response fails to provide a valid explanation as to what the problem was that the students were investigating. The students were not investigating how much mass was in the materials, but rather the effect acidified water had on the materials. The attempt to answer part B is irrelevant to increasing confidence in the students' results.

**CAPT Science Open-Ended Item:
*Antifreeze Gene for Agricultural Crops***

Antifreeze Gene for Agricultural Crops

The DNA of Arctic flounder contains a gene that produces special antifreeze proteins that allow the fish to survive in cold Arctic waters. Geneticists have been able to isolate this gene and insert it into the DNA of certain agricultural crops.

- a) Explain how the antifreeze gene could be beneficial in growing agricultural crops, such as tomatoes.
- b) Describe two concerns a consumer might have regarding the insertion of animal DNA into agricultural crops.

Write your answer in your answer booklet.

Rubric for *Antifreeze Gene for Agricultural Crops*

Possible Correct Responses:

Benefits:

- It could allow certain varieties of agricultural crops to be grown in colder areas where they were previously unable to be planted.
- It could extend the growing season in cold areas for crops that contain the gene, allowing for a longer/larger harvest.
- It could reduce crop loss from early or late frosts.
- Other acceptable responses

Concerns:

- Some crops may become allergenic.
- The crops may cause unknown health risks.
- The flavor of the crops may be compromised.
- There may be unintended effects on the plants.
- Labeling is not required for GM foods and vegetarians wouldn't know whether they were consuming a product that includes animal DNA or not.
- Genetic pollution (pollen from GM crops may cross-pollinate non-GM crops and/or organic crops, rendering farmers unable to certify their crops as organic).
- Reduced genetic variation (farmers may opt to plant only the GM varieties to reap the benefits of the new genes).
- Crops may indirectly promote antibiotic resistance. (In transplanting genes, there is need for a marker to identify which cells have taken up the foreign gene. One way is to attach a gene for antibiotic resistance.)
- Other acceptable responses

3-Point Rubric:

Score 3

The response explains how the antifreeze gene could be beneficial to certain agricultural crops and describes two concerns a consumer might have regarding the insertion of animal DNA into agricultural crops.

Score 2

The response explains how the antifreeze gene could be beneficial to certain agricultural crops and describes one concern a consumer might have regarding the insertion of animal DNA into agricultural crops.

-or-

The response describes two concerns a consumer might have regarding the insertion of animal DNA into agricultural crops, but fails to explain or incorrectly explains how the antifreeze gene could be beneficial to certain agricultural crops.

Score 1

The response explains how the antifreeze gene could be beneficial to certain agricultural crops, but fails to describe or incorrectly describes concerns a consumer might have regarding the insertion of animal DNA into agricultural crops.

-or-

The response describes one concern a consumer might have regarding the insertion of animal DNA into agricultural crops, but fails to explain or incorrectly explains how the antifreeze gene could be beneficial to certain agricultural crops.

Score 0

The response provides little or no accurate or relevant information related to the tasks.

Strand IV: Cell Chemistry and Biotechnology

Expected Performance: D INQ.9 Articulate conclusions and explanations based on research data, and assess results based on the design of the investigation.

Scored Student Responses for Antifreeze Gene for Agricultural Crops

Score 3

a.) The antifreeze gene could be beneficial to agricultural crops because, if there was a frost overnight, then they could survive the cold and be more immune from dying from it.

b.) A concern that consumers might have regarding the DNA might be: will it affect the agricultural crop's flavor or taste? Another concern might be: will this affect the life-span of the plant?

This response provides a valid explanation of how the antifreeze gene could be beneficial in growing agricultural crops: "...if there was a frost overnight, then they could survive the cold and be more immune from dying from it." Two correct and specifically described concerns a consumer might have regarding the insertion of animal DNA into agricultural crops are given: "...will it affect the...taste [and]...will this affect the life-span of the plant?"

Scored Student Responses for Antifreeze Gene for Agricultural Crops

Score 3

- Ⓐ Antifreeze gene would be beneficial in growing tomatoes because tomatoes only grow in warm weather. By putting the antifreeze gene in tomatoes that will allow tomatoes to grow in cold weather.
- Ⓑ Two concerns a consumer might have regarding the insertion of animal DNA into agricultural crops will probably be are there any allergies they should be aware of and will there be any side effects by eating this product. Also will the product still look and taste the same.

This response provides an acceptable explanation of how the antifreeze gene could be beneficial in growing agricultural crops, such as tomatoes: "...tomatoes only grow in warm weather. By putting the antifreeze gene in tomatoes that will allow tomatoes to grow in cold weather." The response also describes more than two appropriate consumer concerns regarding the insertion of animal DNA into agricultural crops: "...are there any allergy's [sic] they should be aware of and will there be any side effects by eating this product. Also will the product still...taste the same."

Scored Student Responses for Antifreeze Gene for Agricultural Crops

Score 2

The antifreeze gene would be useful in crops due to the fact that plants would not have to be constantly replanted. This would save a lot of time, money and energy required to plant new plants every year.

Two concerns might be how might the gene affect the plant. Maybe the tomatoes or corn etc. might be harmed from the insertion of the gene into them.

Also how would ingesting the crop affect humans. No one knows how someone might react to it.

This response incorrectly suggests that the antifreeze gene would decrease the need to replant crops every year. However, two correct and specifically described consumer concerns regarding the insertion of animal DNA into agricultural crops are given: "Maybe the tomatoes or corn etc. might be harmed from the insertion of the gene into them" and "...how would ingesting the crop affect humans."

Scored Student Responses for Antifreeze Gene for Agricultural Crops

Score 2

If we were to splice that gene into tomatoes, then they wouldn't die off in the winter. Consumers may be worried knowing their food was genetically altered or they might think it will taste different and won't be as good.

This response provides a valid explanation of how the antifreeze gene could be beneficial in growing agricultural crops: "...they wouldn't die off in the winter." The response also describes one appropriate consumer concern regarding the insertion of animal DNA into agricultural crops: "...they might think it will taste different and won't be as good." The statement that consumers "may be worried knowing their food was genetically altered" does not provide a specific concern regarding animal DNA in agricultural crops.

Scored Student Responses for *Antifreeze Gene for Agricultural Crops*

Score 1

a) well tomatoes can resist the cold with the antifreeze gene and there will be more production.
b)

This response provides a valid explanation of how the antifreeze gene could be beneficial in growing agricultural crops: "...tomatoes can resist the cold with the antifreeze gene and there will be more production." There is no attempt to describe at least one concern a consumer might have regarding the insertion of animal DNA into agricultural crops.

Scored Student Responses for Antifreeze Gene for Agricultural Crops

Score 1

The antifreeze gene could be beneficial in growing agricultural crops, such as tomatoes because it might help the plants growth system produce more rapidly.

One concern a consumer might have regarding the insertion of animal DNA into agricultural crops is are there any side affects? and if so what are they? The second concern of a consumer is does this actually help the crops?

This response incorrectly suggests that the antifreeze gene could “help the plants growth system produce more rapidly.” However, one appropriate consumer concern regarding the insertion of animal DNA into agricultural crops is provided: “...are there any side affects [sic]?” The second concern given (“...does this actually help the crops?”) is too vague to receive credit.

Scored Student Responses for Antifreeze Gene for Agricultural Crops

Score 0

It would be beneficial in agriculture growing crops because it will produce more tomatoes. The strains will already populate then they would make different ones so they can be in a different family. Well reasoning is that its possible but its an unnecessary trait that needs to be populated.

This response fails to provide a valid explanation of how the antifreeze gene could be beneficial in growing agricultural crops. The statement that "it would be beneficial...because it will produce more tomatoes" is too vague. An attempt is made to describe two consumer concerns regarding the insertion of animal DNA into agricultural crops; however, the concerns offered are unclear.

Scored Student Responses for Antifreeze Gene for Agricultural Crops

Score 0

- A) Well tomatoes needs a lot of water to stay fresh but for most the tomatoes need to be kept healthy and clean and with the antifreeze the tomatoes will get good proteins.
- B) Well some animals might not handle the antifreeze on whole bodies and it can also have a certain chemical that is not made for them

This response incorrectly suggests that the antifreeze gene will provide tomatoes with proteins. The attempts to describe two concerns a consumer might have regarding the insertion of animal DNA into agricultural crops are unsuccessful: the first is incorrect, while the second is too vague to receive credit.

CAPT Science Open-Ended Item: *Polymer Investigation*

Polymer Investigation

A manufacturer claims that its kitchen wrap will stretch twice as much as the leading competitor's plastic wrap without tearing. A group of students has gathered the following materials to test this claim.

- one sample of kitchen wrap from the manufacturer making the claim
- one sample of kitchen wrap from the leading competitor
- masking tape
- one clamp with a hook for adding weights
- several weights
- a metric ruler

The students wrote the following procedure for their investigation.

Procedure:

1. Take the sample of kitchen wrap from the manufacturer making the claim and attach one edge of the wrap to a table or desk with the masking tape (leaving the free end hanging down).
2. Attach the clamp to the free-hanging end of the kitchen wrap.
3. Add weights to the clamp.
4. Measure how much the plastic stretches.
5. Repeat steps 1–4 for the leading competitor's kitchen wrap.

Describe **at least three** steps or pieces of information the students should add to the procedure to improve the design of their experiment.

Write your answer in your answer booklet.

Rubric for *Polymer Investigation*

Possible Correct Responses:

Conclusion:

- make sure each sample of plastic is exactly the same size
- make sure the exact same length of plastic was left free-hanging
- indicate the mass of each weight added to the clamp
- indicate how much time there was between each added weight (how long was each weight allowed to dangle before the next one was added)
- measure the plastic after each weight is added to the clamp
- indicate the total amount of weight each clamp held before the plastic samples began to tear
- apply the weights with the same amount of force
- perform multiple trials
- other acceptable responses

3-Point Rubric:

Score 3

The response describes three steps or pieces of information the students should add to the procedure to improve the validity of the investigation.

Score 2

The response describes two steps or pieces of information the students should add to the procedure to improve the validity of the investigation.

Score 1

The response describes one step or piece of information the students should add to the procedure to improve the validity of the investigation.

Score 0

The response provides little or no correct information.

Strand II: Chemical Structures and Properties

Expected Performance: D INQ.4 Design and conduct appropriate types of scientific investigations to answer different questions.

Scored Student Responses for *Polymer Investigation*

Score 3

First, the student should state in the procedure the specific mass (in grams) of the weights used, and should use all the same types of weights (same mass, shape, etc.).

Second, the student should state in the procedure the original lengths of the wraps (which should both be the same length). This is another variable to be kept constant.

Third, the student should repeat all the steps multiple times to yield more trials and more data, so that the conclusion drawn will be more valid.

This response describes three valid steps or pieces of information the students should add to the procedure to improve the design of the experiment: "...the student should state in the procedure the specific mass (in grams) of the weights used, and should use all the same types of weights (same mass, shape, etc.); "...the student should state...the original lengths of the wraps (which should both be the same length)"; and "...the student should repeat all the steps multiple times to yield more trials and more data...."

Scored Student Responses for *Polymer Investigation*

Score 3

The students need to include the weight of each of the weights being added to the plastic wrap, because different amounts of weight would affect the experiment. The students need to include at what interval the weights are being placed on because "add weights to the clamp" could mean add 1 at a time or 10 at a time, its not clear. The students also need to specify when to measure the plastic wrap, because if it was measured after different amounts of weights for each brand, the results would not be accurate.

This response describes three appropriate steps or pieces of information the students should add to the procedure to improve the validity of the investigation: "The students need to include the weight of each of the weights being added to the plastic wrap..."; "The students need to include at what interval the weights are being placed on [the clamp]"; and "The students also need to specify when to measure the plastic wrap...."

Scored Student Responses for *Polymer Investigation*

Score 2

The students should have a set measurement for the ceran wrap, such as 7 inches, so the sizes are the same. You also need a measurement of how far from the edge you should tape the end of the plastic wrap, such as 2 inch. You would also need to add a step saying tape the length of the plastic wrap.

This response describes two appropriate steps or pieces of information the students should add to the procedure to improve the validity of the investigation: "...a set measurement for the ceran [sic] wrap, such as 7 inches, so the sizes are the same" and "...a measurement of how far from the edge you should tape the end of the plastic wrap..." The latter step correctly implies that the exact same length of kitchen wrap should be left free-hanging. The final suggestion ("...add a step saying tape the length of the plastic wrap") is similar to the first step given in the procedure.

Scored Student Responses for *Polymer Investigation*

Score 2

The students should have added how much kitchen wrap should be used in the experiment, what weight the weights used in the experiment should be, and they forgot to mention to record the results of the experiment. Also, people doing this experiment should know when to stop adding weights. If they keep adding weights, the ~~pl~~ kitchen plastic might break.

This response describes two valid steps or pieces of information the students should add to the procedure to improve the design of the experiment: "The students should have added how much kitchen wrap should be used in the experiment, [and] what weight the weights used in the experiment should be...." Recording the results of the experiment and knowing when to stop adding weights would not improve the validity of this investigation.

Scored Student Responses for *Polymer Investigation*

Score 1

1) measure how much plastic wrap is being stretched.

2) How much each weight weighs

3) How much tape he uses.

This response describes one appropriate step or piece of information the students should add to the procedure to improve the validity of the investigation: "How much each weight weighs." "Measure how much plastic wrap is being stretched" is similar to the fourth step given in the procedure, and "How much tape he uses" is not a valid improvement.

Scored Student Responses for *Polymer Investigation*

Score 1

- ① use all safety precautions
- ② Hold the wrap so that it doesn't slip off the table.
3. cut out or take pieces that are identical.

This response describes one valid step or piece of information the students should add to the procedure to improve the design of the experiment: "Cut out or take pieces that are identical." This step correctly suggests that each sample of plastic should be exactly the same size. "Use all safety precautions" and "Hold the wrap so that it doesn't slip off the table" will not improve the validity of the investigation.

Scored Student Responses for *Polymer Investigation*

Score 0

First of all I believe that this experiment would not be effective because the plastic could break due to the clamp or the masking tape not being strong enough to hold it up. So I would change the table to an empty coffee can, change the masking tape to a rubber band, and just add the weights one by one, measuring from the top of the coffee can down to where the plastic wrap has sunk. Changing these steps will improve the validity of the student's experiment design.

This response suggests changing the entire design of the experiment rather than adding to it, thus failing to provide any valid steps or pieces of information the students should add to the procedure to improve the validity of the investigation.

Scored Student Responses for *Polymer Investigation*

Score 0

This is how you put ~~it~~ it together
you have put in order than start adding
it.

This response provides little or no correct information as to how the students could improve the validity of the investigation.

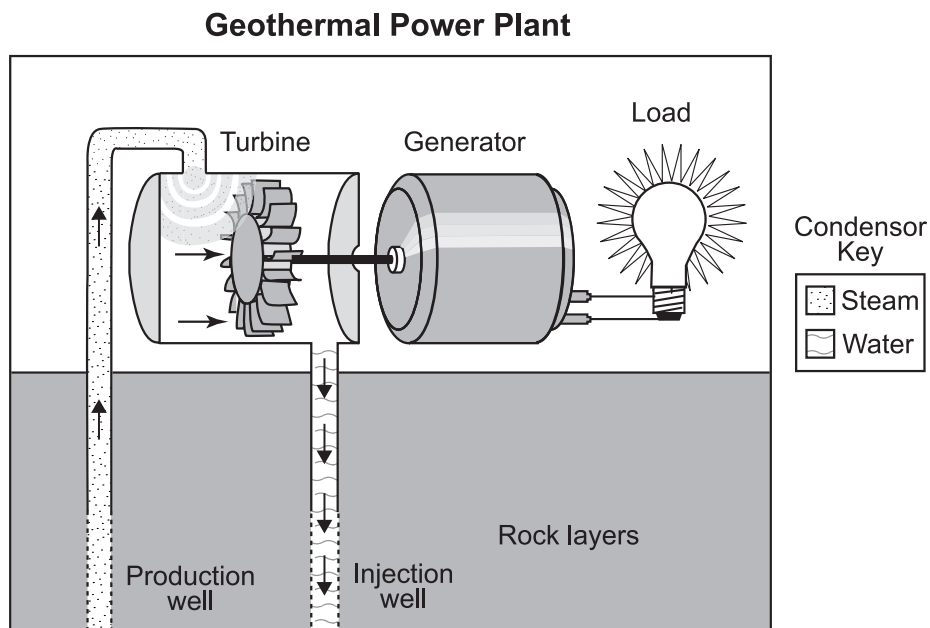
CAPT Science Multiple-Choice Items

1. A student coils a bare copper wire around a metal rod and attaches the ends of the wire to an ammeter. He quickly moves a magnet past the coil and notes the resulting current. How could the student alter this apparatus to create a larger current?
- a. use thinner wire
 - b. use insulated wire
 - c. increase the length of the rod that is used
 - d. increase the number of times the wire is coiled around the rod ⚡

Strand I: Energy Transformations

Expected Performance: D INQ.6 Use appropriate tools and techniques to make observations and gather data.

2. The picture below shows a turbine generator used to produce electricity at a geothermal power plant.



Electricity is produced by using steam to _____.

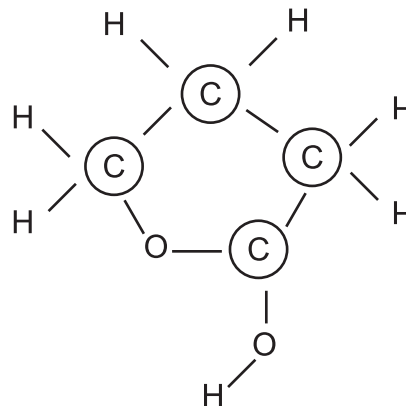
- f. heat the turbine generators
- g. spin the turbine generators ⚡
- h. reduce friction in the turbine generators
- j. reduce emissions from the turbine generators

Strand I: Energy Transformations

Expected Performance: D 7. Explain how heat is used to generate electricity.

CAPT Science Multiple-Choice Items

3. The pictures below show the structures of two polymers.



What can be concluded from comparing these two pictures?

- Polymers are easily broken down into their component parts.
- The same number of carbon atoms may be arranged in various ways. ⚡
- Linear polymer structures are stronger than ringed polymer structures.
- It takes fewer monomers to form a linear polymer than a ringed polymer.

Strand II: Chemical Structures and Properties

Expected Performance: D 16. Explain how simple chemical monomers can be combined to create linear, branched, and/or cross-linked polymers.

4. Researchers have developed a biopolymer made from orange peels and carbon dioxide. According to the researchers, using CO_2 to make polymers could reduce the amount of greenhouse gas emitted into the atmosphere. What question would an environmentalist **most likely** want answered before accepting this statement as credible?
- How long will it take the biopolymer to decompose?
 - Is the biopolymer as strong as hydrocarbon polymers?
 - Can other types of citrus be used to produce biopolymers?
 - What happens to the CO_2 when the biopolymer decomposes? ⚡

Strand II: Chemical Structures and Properties

Expected Performance: D INQ.1 Identify questions that can be answered through scientific investigation.

CAPT Science Multiple-Choice Items

The London Smog Disaster of 1952

On December 5, 1952, London, England, experienced temperatures that were much colder than normal. As a result, large amounts of coal were burned in furnaces to keep residences warm. This occurred at the same time as the formation of a heavy fog. Water from the fog condensed around airborne soot particles, and a thick smog quickly developed. Nearly 12,000 human deaths resulted.

5. In addition to soot, what product of the burning coal contributed **most** to the extreme pollution of London's air?
- a. uranium (U)
 - b. methane (CH₄)
 - c. sulfur dioxide (SO₂) ⚡
 - d. chlorofluorocarbons (CFCs)

Strand III: Global Interdependence

Expected Performance: D 22. Explain how the release of sulfur dioxide (SO₂) into the atmosphere can form acid rain, and how acid rain affects water sources, organisms, and human-made structures.

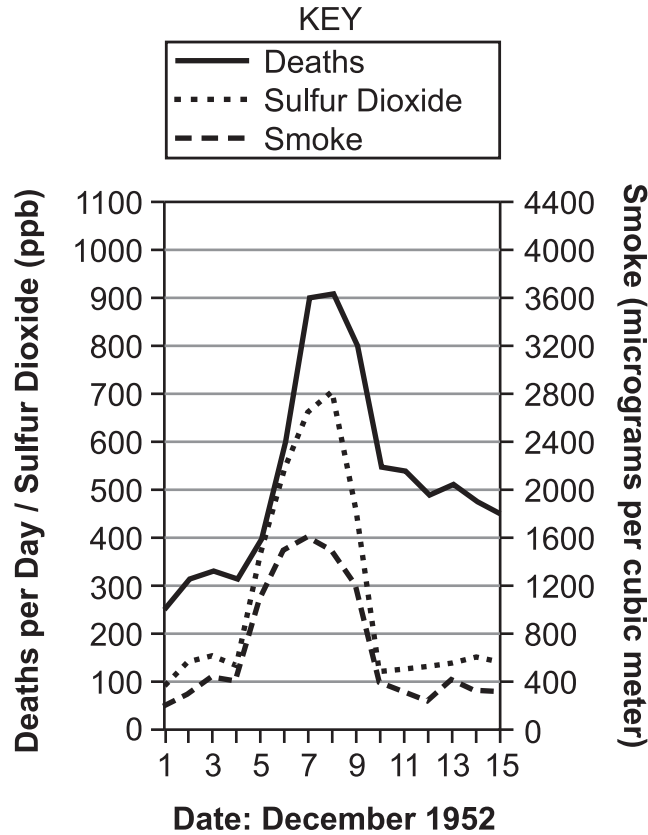
6. Which government action was **most likely** the result of the London smog disaster of 1952?
- f. establishment of youth curfews after dark
 - g. creation of a privately funded healthcare system
 - h. conversion from underground mining for coal to strip mining for coal
 - j. provision of grants for homeowners to convert to gas or oil-fueled heaters ⚡

Strand III: Global Interdependence

Expected Performance: D 26. Describe human efforts to reduce the consumption of raw materials and improve air and water quality.

CAPT Science Multiple-Choice Items

7. The graph below shows the correlation between pollutants and human deaths during the London smog disaster of 1952.



Which conclusion is **best** supported by the data?

- a. Acid rain fell from December 4 to December 10.
- b. Smoke caused more deaths than sulfur dioxide.
- c. Sulfur dioxide remains in the air longer than smoke.
- d. Air pollution peaked between December 7 and December 8. ⓧ

Strand III: Global Interdependence

Expected Performance: D INQ.7 Assess the reliability of the data that was generated in the investigation.

CAPT Science Multiple-Choice Items

8. Students placed a sample of red blood cells (RBC) and a sample of skin cells in 2 test tubes that contained the same glucose solution. After 24 hours, the students observed the cells under the microscope and found that the cells in both samples increased in size. What conclusion might be drawn from this observation?
- f. The cytoplasm of the red blood cells is more concentrated than that of the skin cells.
 - g. Skin cells absorb water faster than the red blood cells.
 - h. Both cells absorb water when placed in the glucose solution. ⚡
 - j. Both cells absorb water when placed in any solution.

Strand IV: Cell Chemistry and Biotechnology

Expected Performance: D INQ.9 Articulate conclusions and explanations based on research data, and assess results based on the design of the investigation.

9. Depending on its electric charge, shape, and chemical properties, a substance may or may not be allowed to pass through a cell membrane. This function of the cell membrane is important because it _____.
- a. prevents cell division
 - b. prevents destruction of the cell wall
 - c. allows the cell to maintain homeostasis ⚡
 - d. allows amino acids to move into and out of the cell

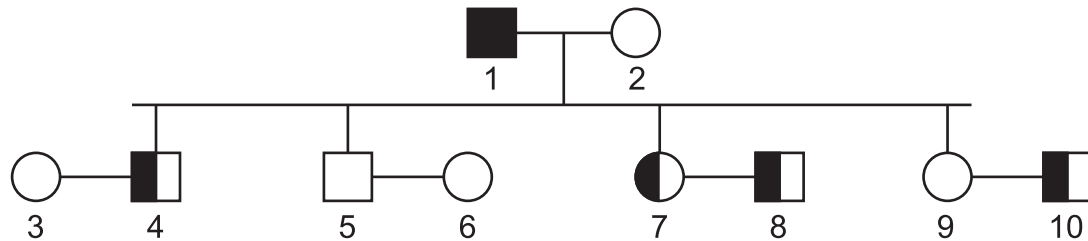
Strand IV: Cell Chemistry and Biotechnology

Expected Performance: D 30. Explain the role of the cell membrane in supporting cell functions.

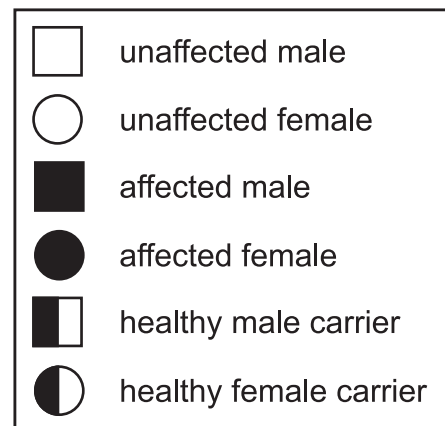
CAPT Science Multiple-Choice Items

Cystic Fibrosis

Cystic fibrosis (CF) is a condition characterized by difficulty in breathing and digestion. CF is caused by a defect in a specific gene. The pedigree diagram below shows the inheritance pattern of cystic fibrosis in two generations of a family.



KEY



10. Which couple has a 25% probability of producing offspring who are homozygous for cystic fibrosis?
- f. 3 and 4
 - g. 5 and 6
 - h. 7 and 8 ⚡
 - j. 9 and 10

Strand V: Genetics, Evolution and Biodiversity

Expected Performance: D 37. Use the Punnet Square technique to predict the distribution of traits in mono- and di-hybrid crossings.

CAPT Science Multiple-Choice Items

11. An individual with CF is **not** able to transmit the disease by physical contact because _____.
- a. the gene for the disorder is only carried in the bloodstream
 - b. CF is a genetic disorder and can only be passed from parent to offspring ⓧ
 - c. the bacteria that transmit the defective gene must be inherited from a parent
 - d. CF is so rare that the probability of coming into contact with an affected individual is low

Strand V: Genetics, Evolution and Biodiversity

Expected Performance: D 39. Describe the difference between genetic disorders and infectious diseases.