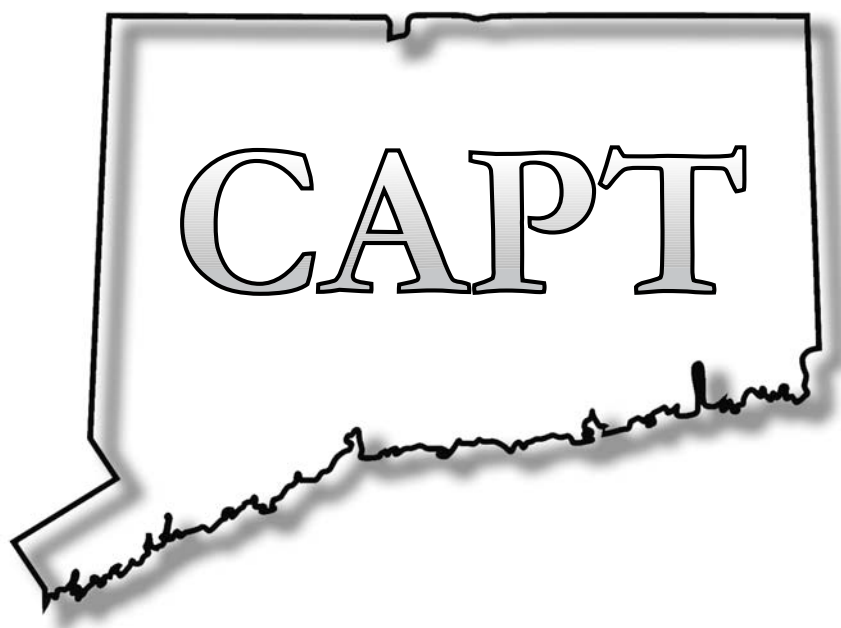


**CAPT Science  
2009 Administration**



**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
<b>I. Energy Transformations</b>	8	4	1	15
<b>II. Chemical Structures &amp; Properties</b>	8	4	1	15
<b>III. Global Interdependence</b>	8	4	1	15
<b>IV. Cell Chemistry &amp; Biotechnology</b>	8	4	1	15
<b>V. Genetics, Evolution &amp; Biodiversity</b>	8	4	1	15
<b>Totals</b>	<b>40 MC Items</b>	<b>20 MC Items</b>	<b>5 OE Items</b>	<b>75 Points</b>

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.**

<b>Grades 9–10 Core Scientific Inquiry, Literacy, and Numeracy</b>	
<i>How is scientific knowledge created and communicated?</i>	
<b>Content Standards</b>	<b>Expected Performances</b>
<p><b>SCIENTIFIC INQUIRY</b></p> <ul style="list-style-type: none"> <li>◆ Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain, and predict natural phenomena.</li> <li>◆ Scientific inquiry progresses through a continuous process of questioning, data collection, analysis, and interpretation.</li> <li>◆ Scientific inquiry requires the sharing of findings and ideas for critical review by colleagues and other scientists.</li> </ul> <p><b>SCIENTIFIC LITERACY</b></p> <ul style="list-style-type: none"> <li>◆ Scientific literacy includes the ability to read, write, discuss, and present coherent ideas about science.</li> <li>◆ 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.</li> </ul> <p><b>SCIENTIFIC NUMERACY</b></p> <ul style="list-style-type: none"> <li>◆ Scientific numeracy includes the ability to use mathematical operations and procedures to calculate, analyze, and present scientific data and ideas.</li> </ul>	<p><b>D INQ.1</b> Identify questions that can be answered through scientific investigation.</p> <p><b>D INQ.2</b> Read, interpret, and examine the credibility and validity of scientific claims in different sources of information.</p> <p><b>D INQ.3</b> Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.</p> <p><b>D INQ.4</b> Design and conduct appropriate types of scientific investigations to answer different questions.</p> <p><b>D INQ.5</b> Identify independent and dependent variables, including those that are kept constant and those used as controls.</p> <p><b>D INQ.6</b> Use appropriate tools and techniques to make observations and gather data.</p> <p><b>D INQ.7</b> Assess the reliability of the data that was generated in the investigation.</p> <p><b>D INQ.8</b> Use mathematical operations to analyze and interpret data, and present relationships between variables in appropriate forms.</p> <p><b>D INQ.9</b> Articulate conclusions and explanations based on research data, and assess results based on the design of the investigation.</p> <p><b>D INQ.10</b> 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><b>9.1 - Energy cannot be created or destroyed; however, energy can be converted from one form to another.</b></p> <ul style="list-style-type: none"> <li>◆ Energy enters the Earth system primarily as solar radiation, is captured by materials and photosynthetic processes, and eventually is transformed into heat.</li> </ul>	<p><b>D 1.</b> Describe the effects of adding energy to matter in terms of the motion of atoms and molecules, and the resulting phase changes.</p> <p><b>D 2.</b> Explain how energy is transferred by conduction, convection, and radiation.</p> <p><b>D 3.</b> 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><b>9.2 - The electrical force is a universal force that exists between any two charged objects.</b></p> <ul style="list-style-type: none"> <li>◆ Moving electrical charges produce magnetic forces, and moving magnets can produce electrical force.</li> <li>◆ Electrical current can be transformed into light through the excitation of electrons.</li> </ul>	<p><b>D 4.</b> Explain the relationship among voltage, current, and resistance in a simple series circuit.</p> <p><b>D 5.</b> Explain how electricity is used to produce heat and light in incandescent bulbs and heating elements.</p> <p><b>D 6.</b> 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><b>9.3 - Various sources of energy are used by humans and all have advantages and disadvantages.</b></p> <ul style="list-style-type: none"> <li>◆ During the burning of fossil fuels, stored chemical energy is converted to electrical energy through heat transfer processes.</li> <li>◆ In nuclear fission, matter is transformed directly into energy in a process that is several million times as energetic as chemical burning.</li> <li>◆ Alternative energy sources are being explored and used to address the disadvantages of using fossil and nuclear fuels.</li> </ul>	<p><b>D 7.</b> Explain how heat is used to generate electricity.</p> <p><b>D 8.</b> Describe the availability, current uses, and environmental issues related to the use of fossil and nuclear fuels to produce electricity.</p> <p><b>D 9.</b> 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><b>9.4 - Atoms react with one another to form new molecules.</b></p> <ul style="list-style-type: none"><li>◆ Atoms have a positively charged nucleus surrounded by negatively charged electrons.</li><li>◆ The configuration of atoms and molecules determines the properties of the materials.</li></ul>	<p><b>D 10.</b> 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><b>D 11.</b> Describe how atoms combine to form new substances by transferring electrons (ionic bonding) or sharing electrons (covalent bonding).</p> <p><b>D 12.</b> 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><b>9.5 - Due to its unique chemical structure, carbon forms many organic and inorganic compounds.</b></p> <ul style="list-style-type: none"><li>◆ 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.</li></ul>	<p><b>D 13.</b> Explain how the structure of the carbon atom affects the type of bonds it forms in organic and inorganic molecules.</p> <p><b>D 14.</b> Describe combustion reactions of hydrocarbons and their resulting by-products.</p> <p><b>D 15.</b> 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><b>9.6 - Chemical technologies present both risks and benefits to the health and well-being of humans, plants and animals.</b></p> <ul style="list-style-type: none"><li>◆ Materials produced from the cracking of petroleum are the starting points for the production of many synthetic compounds.</li><li>◆ The products of chemical technologies include synthetic fibers, pharmaceuticals, plastics, and fuels.</li></ul>	<p><b>D 16.</b> Explain how simple chemical monomers can be combined to create linear, branched, and/or cross-linked polymers.</p> <p><b>D 17.</b> Explain how the chemical structure of polymers affects their physical properties.</p> <p><b>D 18.</b> 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><b>9.7 - Elements on Earth move among reservoirs in the solid earth, oceans, atmosphere, and organisms as part of biogeochemical cycles.</b></p> <ul style="list-style-type: none"> <li>◆ Elements on Earth exist in essentially fixed amounts and are located in various chemical reservoirs.</li> <li>◆ The cyclical movement of matter between reservoirs is driven by the Earth’s internal and external sources of energy.</li> </ul>	<p><b>D 19.</b> Explain how chemical and physical processes cause carbon to cycle through the major earth reservoirs.</p> <p><b>D 20.</b> Explain how solar energy causes water to cycle through the major earth reservoirs.</p> <p><b>D 21.</b> 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><b>9.8 - The use of resources by human populations may affect the quality of the environment.</b></p> <ul style="list-style-type: none"> <li>◆ Emission of combustion by-products, such as SO<sub>2</sub>, CO<sub>2</sub>, and NO<sub>x</sub> by industries and vehicles is a major source of air pollution.</li> <li>◆ Accumulation of metal and non-metal ions used to increase agricultural productivity is a major source of water pollution.</li> </ul>	<p><b>D 22.</b> Explain how the release of sulfur dioxide (SO<sub>2</sub>) into the atmosphere can form acid rain, and how acid rain affects water sources, organisms, and human-made structures.</p> <p><b>D 23.</b> Explain how the accumulation of carbon dioxide (CO<sub>2</sub>) in the atmosphere increases Earth’s “greenhouse” effect and may cause climate changes.</p> <p><b>D 24.</b> 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><b>9.9 - Some materials can be recycled, but others accumulate in the environment and may affect the balance of the Earth systems.</b></p> <ul style="list-style-type: none"> <li>◆ New technologies and changes in lifestyle can have positive and/or negative effects on the environment.</li> </ul>	<p><b>D 25.</b> Explain how land development, transportation options, and consumption of resources may affect the environment.</p> <p><b>D 26.</b> 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><b>10.1 - Fundamental life processes depend on the physical structure and the chemical activities of the cell.</b></p> <ul style="list-style-type: none"> <li>◆ Most of the chemical activities of the cell are catalyzed by enzymes that function only in a narrow range of temperature and acidity conditions.</li> <li>◆ The cellular processes of photosynthesis and respiration involve transformation of matter and energy.</li> </ul>	<p><b>D 27.</b> Describe significant similarities and differences in the basic structure of plant and animal cells.</p> <p><b>D 28.</b> Describe the general role of DNA and RNA in protein synthesis.</p> <p><b>D 29.</b> Describe the general role of enzymes in metabolic cell processes.</p> <p><b>D 30.</b> 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><b>10.2 - Microorganisms have an essential role in life processes and cycles on Earth.</b></p> <ul style="list-style-type: none"> <li>◆ Understanding the growth and spread patterns of viruses and bacteria enables the development of methods to prevent and treat infectious diseases.</li> </ul>	<p><b>D 31.</b> Describe the similarities and differences between bacteria and viruses.</p> <p><b>D 32.</b> 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><b>D 33.</b> 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><b>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.</b></p> <ul style="list-style-type: none"> <li>◆ The principles of genetics and cellular chemistry can be used to produce new foods and medicines in biotechnological processes.</li> </ul>	<p><b>D 34.</b> Describe, in general terms, how the genetic information of organisms can be altered to make them produce new materials.</p> <p><b>D 35.</b> 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><b>10.4 - In sexually reproducing organisms, each offspring contains a mix of characteristics inherited from both parents.</b></p> <ul style="list-style-type: none"> <li>◆ Genetic information is stored in genes that are located on chromosomes inside the cell nucleus.</li> <li>◆ Most organisms have two genes for each trait, one on each of the homologous chromosomes in the cell nucleus.</li> </ul>	<p><b>D 36.</b> Explain how meiosis contributes to the genetic variability of organisms.</p> <p><b>D 37.</b> Use the Punnet Square technique to predict the distribution of traits in mono- and di-hybrid crossings.</p> <p><b>D 38.</b> Deduce the probable mode of inheritance of traits (e.g., recessive/dominant, sex-linked) from pedigree diagrams showing phenotypes.</p> <p><b>D 39.</b> 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><b>10.5 - Evolution and biodiversity are the result of genetic changes that occur over time in constantly changing environments.</b></p> <ul style="list-style-type: none"> <li>◆ Mutations and recombination of genes create genetic variability in populations.</li> <li>◆ Changes in the environment may result in the selection of organisms that are better able to survive and reproduce.</li> </ul>	<p><b>D 40.</b> Explain how the processes of genetic mutation and natural selection are related to the evolution of species.</p> <p><b>D 41.</b> Explain how the current theory of evolution provides a scientific explanation for fossil records of ancient life forms.</p> <p><b>D 42.</b> 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><b>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.</b></p> <ul style="list-style-type: none"> <li>◆ Human populations grow due to advances in agriculture, medicine, construction, and the use of energy.</li> <li>◆ Humans modify ecosystems as a result of rapid population growth, use of technology, and consumption of resources.</li> </ul>	<p><b>D 43.</b> Describe the factors that affect the carrying capacity of the environment.</p> <p><b>D 44.</b> 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><b>D 45.</b> 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: *Enzyme Investigation*

## Enzyme Investigation

A group of students hypothesized that adding an enzyme to applesauce would produce more juice than adding an enzyme to mashed pears. The students wrote the following procedure for their investigation.

### Procedure:

1. Place a coffee filter in each of two plastic funnels and place each funnel in a separate beaker.
2. Put 113 g of applesauce in one filter-covered funnel.
3. Put 113 g of peeled, mashed pears in one filter-covered funnel.
4. Add 3 drops of enzyme A to the applesauce and stir for one minute.
5. Add 3 drops of enzyme B to the mashed pears and stir for one minute.
6. Allow the fruit to sit for 10 minutes.
7. Measure and record the amount of juice contained in each beaker.
8. Repeat the procedure exactly for a second trial to verify data.

The data collected during the investigation are shown in the table below.

Type of Fruit	Juice Produced (mL)		
	Trial 1	Trial 2	Average
Applesauce	12	11	11.5
Mashed Pears	13	12	12.5

The students claimed that their original hypothesis was correct.

- a) Explain why the credibility of the students' claim should be questioned.
- b) Describe two changes that the students should make to their procedure that would allow their original hypothesis to be more accurately tested and/or would ensure the accuracy of their results.

**Write your answer in your answer booklet.**

# Rubric for *Enzyme Investigation*

Possible Correct Responses:

## Credibility Problem:

- The procedure allowed for more than one variable.
- The students used different enzymes in each type of fruit.
- Data doesn't support the claim.
- Other acceptable responses

## Changes:

- Use the same enzyme in each type of fruit (either A or B, but not both).
- Use both enzymes on each fruit.
- Add a control to the investigation (a sample of each fruit to which no enzyme is added).
- Perform additional trials.
- Other acceptable responses

## **3-Point Rubric:**

### Score 3

The response provides an explanation for why the credibility should be questioned and describes two changes the students could make that would allow their original hypothesis to be more accurately tested and/or would ensure the accuracy of their results.

### Score 2

The response provides an explanation for why the credibility should be questioned and describes one change the students could make that would allow their original hypothesis to be more accurately tested and/or would ensure the accuracy of their results.

-or-

The response fails to provide or provides an incorrect explanation for why the credibility should be questioned, but describes two changes the students could make that would allow their original hypothesis to be more accurately tested and/or would ensure the accuracy of their results.

### Score 1

The response provides an explanation for why the credibility should be questioned, but fails to correctly describe any changes.

-or-

The response fails to provide or provides an incorrect explanation for why the credibility should be questioned, but describes one change.

### Score 0

The response describes little or no accurate or relevant information related to the enzyme investigation.

## **Strand IV: Cell Chemistry and Biotechnology**

**Expected Performance:** D INQ.2 Read, interpret, and examine the credibility and validity of scientific claims in different sources of information.

## Scored Student Responses for Enzyme Investigation

### Score 3

The students claim does not have credibility because they test two different enzymes on different fruits. Since the type of enzyme was not kept constant the larger or smaller amount of Juiced produced could have been because of the enzyme type and not the fruit. Also, the data shows that their hypothesis is incorrect as mashed pears produced more juice. To improve this experiment the students should keep constant the type of enzyme added and include more trials to increase the validity of the experiment.

This response provides an acceptable explanation as to why the credibility of the students' claim should be questioned: "they test[ed] two different enzymes on different fruits ... the data shows that their hypothesis is incorrect as mashed pears produced more juice." Both explanations are acceptable but only one of them is needed for full credit. Two correct and specifically described changes that the students should make to their procedure that would allow their original hypothesis to be more accurately tested and/or would ensure the accuracy of their results are given: "the students should keep constant the type of enzymes added and include more trials."

## Scored Student Responses for Enzyme Investigation

### Score 3

A) The credibility of the student's claim should be questioned because they hypothesized that apple sauce would produce more juice with an enzyme than mashed pears with an enzyme. But, the mashed pears produced more juice in both trials.

B) Two changes the students should are, to first have each type of fruit be tested for both enzyme A and B. That way the credibility of the experiment could not be questioned. Finally, they should have a control for each type of fruit, to show the effect of the enzymes.

This response provides an acceptable explanation as to why the credibility of the students' claim should be questioned: "...they hypothesized that applesauce would produce more juice with an enzyme than mashed pears with an enzyme. But, the mashed pears produced more juice in both trials." Two correct and specifically described changes that the students should make to their procedure that would allow their original hypothesis to be more accurately tested and/or would ensure the accuracy of their results are given: "have each type of fruit be tested for both enzyme A and B"; "they should have a control for each type of fruit."



## Scored Student Responses for *Enzyme Investigation*

### Score 2

A. He never said the amount of Eggs in the ~~table~~ table.

B. Put Both enzymes in Both Fruit, and make another trial for control.

This response fails to provide an acceptable explanation as to why the credibility of the students' claim should be questioned. The answer for part A seems to suggest that a better recording of data would improve the students' credibility, but this is incorrect. However, two correctly described changes that the students should make to their procedure that would allow their original hypothesis to be more accurately tested and/or would ensure the accuracy of their results are provided: "Put both enzymes on each fruit, and make another trial."

## Scored Student Responses for Enzyme Investigation

### Score 2

A) The students claim should be questioned because obviously the pears produce ~~More JUICE~~

B) First off use the same enzyme for apple sauce & pear. Second off, I don't know.

This response provides an acceptable explanation as to why the credibility of the students' claim should be questioned: "obviously the pears produce more juice." One correctly described change that the students should make to their procedure that would allow their original hypothesis to be more accurately tested and/or would ensure the accuracy of their results is given: "use the same enzyme for applesauce and pear."

## Scored Student Responses for *Enzyme Investigation*

### Score 1

A) It should be questioned because they said to repeat the procedure "exactly" for a second trial. Doing the same thing twice, exactly is not easy.

B) One change that the students should make is using the same enzyme. Another change should be using a larger amount of fruit and a easy to remember number such as "150".

This response fails to provide an acceptable explanation as to why the credibility of the students' claim should be questioned. Repeating the procedure is in fact what increases credibility, and its relative difficulty is irrelevant to the task. However, one change that the students should make to their procedure that would allow their original hypothesis to be more accurately tested and/or would ensure the accuracy of their results is correctly described: "use the same enzyme." "Using a larger amount of fruit" has no bearing on accuracy, and it isn't clear what using an "easy to remember number" means.

## Scored Student Responses for *Enzyme Investigation*

### Score 1

Apple Sauce has more ingredients than mashed pears do, more  
to change.

They should have used the same enzymes for both, a in  
trial 1 and b in trial 2

This response fails to provide an acceptable explanation as to why the credibility of the students' claim should be questioned. In addition to being unclear, it is irrelevant to the task that one fruit has "more ingredients" than another. However, one correctly described change that the students should make to their procedure that would allow their original hypothesis to be more accurately tested and/or would ensure the accuracy of their results is given: "They should have used the same enzymes for both, a in trial 1 and b in trial 2."

## Scored Student Responses for *Enzyme Investigation*

Score 0

b) They could of had the apple sauce and  
mashed pears sit over night. They could have  
doubled the drops.

This response fails to provide a valid response as to why the credibility of the students' claim should be questioned. Only part B is attempted and it is not clear how either having the apple sauce and mashed pears "sit over night" or having "doubled the drops" would be relevant to accuracy.

## Scored Student Responses for *Enzyme Investigation*

Score 0

A) The students should question where all the liquids are at, like where they go.

B.) obviously the enzyme make's some of the apple sauce and mashed pears dry up. so each trial the enzyme made the liquid dry up so each trial half an ounce went away. the liquid went away every .5.

This response fails to provide a valid response as to why the credibility of the students' claim should be questioned. The location of the liquids is irrelevant. Providing speculation about the effect enzymes have on fruit instead of providing two changes that would ensure better accuracy of the students' results demonstrates a lack of understanding of the task.

# CAPT Science Open-Ended Item: *Solar Cooker Investigation*

## Solar Cooker Investigation

A student hypothesized that container size will affect the performance of solar cookers in heating water. The student wrote and performed the following procedure to support her claim.

### Procedure:

1. Line three identical cardboard boxes with aluminum foil to use as solar cookers.
2. Place the solar cookers outside in direct sunlight.
3. Place a large glass container of water in the center of the first box.
4. Record the initial temperature of the water.
5. Allow the container to sit in the sun for 2 hours, and then check and record the final temperature of the water.
6. Place a medium-sized glass container of water in the center of the second box.
7. Repeat steps 4 and 5.
8. Place a small-sized glass container of water in the center of the last box.
9. Repeat steps 4 and 5.

The chart below shows the student's data.

**Solar Cooker Data**

Container	Temperature (°C)	
	Initial	Final
Large	39	48
Medium	39	49
Small	39	49

- a) Draw a conclusion regarding container size and the effectiveness of solar cookers in heating water, based on the student's results.
- b) Describe two ways the student could have improved her experimental design and/or the validity of her results.

**Write your answer in your answer booklet.**

# Rubric for *Solar Cooker Investigation*

Possible Correct Responses:

## Conclusion:

- Container size appears to have little or no effect on the efficiency of solar cookers.
- Small or medium-sized containers heat water more than larger containers.
- The investigation was not conclusive because the student failed to take temperature readings during the two hours, and while the final temperatures were similar, one container may have heated to that temperature faster than the others.
- Other acceptable variations

NOTE: If the student takes the position that the investigation results were inconclusive, the student must explain why. No credit will be awarded for simply stating that the investigation was not conclusive.

## Experimental Design Improvements:

- Clearly indicate the amount of water that was put in each container, making sure it is identical.
- Check and record the temperature at frequent and equal time increments during the investigation.
- Perform additional trials; repeat the investigation exactly.
- Add more containers of varying size to the investigation.
- Test the three solar cookers at the same time.
- Add a control (water in a container outside of the solar cookers).
- Use an artificial light source because the sun's rays vary due to clouds, etc.
- Other acceptable responses

## **3-Point Rubric:**

### Score 3

The response provides a reasonable conclusion and describes two ways the student could have improved her experimental design.

### Score 2

The response provides a reasonable conclusion and describes one way the student could have improved her experimental design.

-or-

The response describes two ways the student could have improved her experimental design, but fails to provide a reasonable conclusion.

### Score 1

The response provides a reasonable conclusion, but fails to describe how the student could have improved her experimental design.

-or-

The response describes one way the student could have improved her experimental design, but fails to provide a reasonable conclusion.

### Score 0

The response describes little or no accurate or relevant information related to the solar cooker investigation.

## **Strand I: Energy Transformations**

**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 Solar Cooker Investigation

### Score 3

a) The difference in the effectiveness is not much, but based on the student's results, the medium and small cup were more effective

b) The student could have specified the number of mLs. of water to use to have a constant. To make her results more precise, she could have multiple trials.

This response provides a valid conclusion, "...the medium and small cup[s] were more effective" as well as two acceptable ways the student could have improved her experimental design and/or the validity of her results: "specify the number of mL of water to use"; "have multiple trials."

## Scored Student Responses for Solar Cooker Investigation

### Score 3

- a) According to the student's results, the medium and small containers heated the water better than the large container. The solar cooker was least effective on the large container, probably because there was more water to heat up.
- b) The student should do more trials of her experiment to ensure precision. She cannot base her conclusion on one trial. The student should also specify the size of her containers. I think if she puts all the solar cookers out in the sun at the same time, they might heat up before she uses them. She should either experiment on all the bowls at the same time, or wait to put the cookers in the sun until she needs them.

This response provides a valid conclusion: "...the medium and small containers heated the water better than the large container. The solar cooker was least effective on the large container." Two acceptable ways the student could have improved her experimental design and/or the validity of her results are given: "The student should do more trials"; "she should...experiment on all the bowls at the same time."

## Scored Student Responses for Solar Cooker Investigation

### Score 2

a) The large and medium containers are the most effective of the solar cookers in heating water based on the student's results because they both went up 10° from initial to final temperature. The small container only went up by 9° from initial + final.

b) The student could have improved her results validity by performing more trials for each size container. She also could have improved her experiment by creating a constant of a bowl of water w/out being in a solar cooker.

This response incorrectly states that the "large and medium containers are the most effective of the solar cookers." However, two acceptable ways the student could have improved her experimental design and/or the validity of her results are described: "performing more trials"; "creating a constant of a bowl of water without being in a solar cooker."

## Scored Student Responses for Solar Cooker Investigation

### Score 2

In this experiment the container size mattered. I know this because in the experiment they told us that the medium and small one show greater increase in temperature, then the large container.

The students could tell us what the temperature was outside. They only did one trial when they could have done more.

This response provides a valid conclusion, "the medium and small [containers] show greater increase in temperature than the large container," as well as one acceptable way the student could have improved her experimental design and/or the validity of her results: "They only did one trial when they could have done more." Merely reporting "what the temperature was outside" does not improve the validity of her results.

## Scored Student Responses for Solar Cooker Investigation

Score 1

a - The large container ended up with 48°C  
medium and small container ended up with 49°C  
b - The student's should have put all the  
three containers by the sun at the same time.

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This response fails to provide a valid conclusion and instead merely reports data from the chart. However, one acceptable way the student could have improved her experimental design and/or the validity of her results is described: "The students should have put all the three containers by the sun at the same time."

## Scored Student Responses for Solar Cooker Investigation

Score 1

A) It didn't matter how big the containers were. They all came out to be  $48^{\circ}$  or  $49^{\circ}$

B) The student could have put in black paper. Because Black attracts heat.

This response provides a valid conclusion: "It didn't matter how big the containers were." The use of black paper "because black attracts heat" does not improve her experimental design and/or the validity of her results.

## Scored Student Responses for *Solar Cooker Investigation*

Score 0

If the cooking room is cooler the water will be cooler  
but ~~the~~ if the room it is hot then the air will  
be hot.

This response demonstrates a misunderstanding of the task. Instead of focusing on the relationship between size of solar cookers and the heating of water, there seems to be a suggestion that the temperature of the atmosphere affects the temperature of the water.

## Scored Student Responses for *Solar Cooker Investigation*

Score 0

I think that the solar cookers work.  
have it be a box and it needs tin foil.

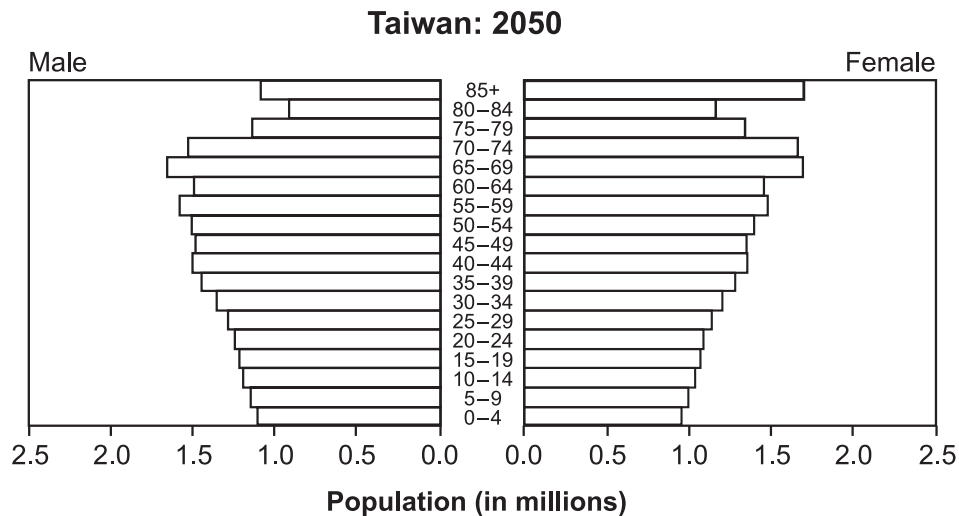
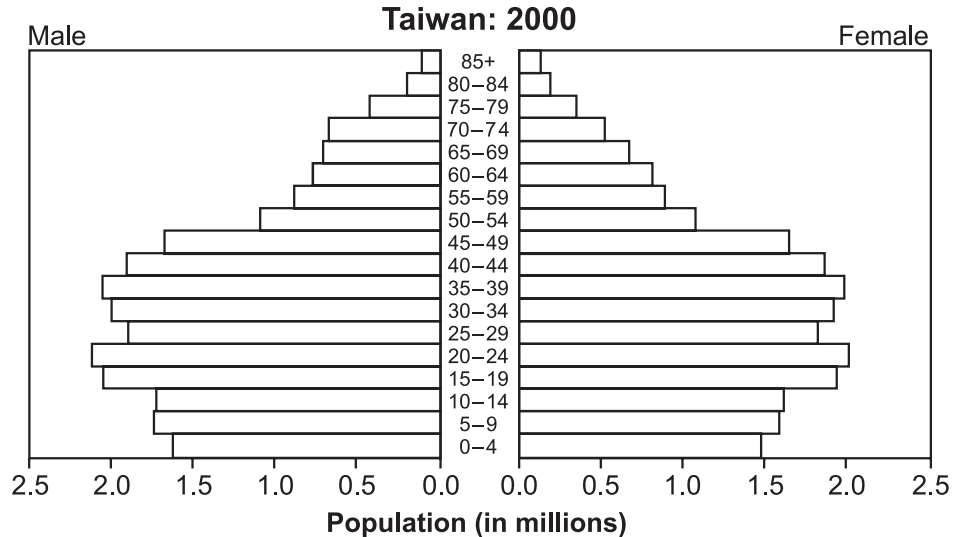
This response demonstrates a misunderstanding of the task. The item is not asking whether solar cookers work, and it is unclear how a box and tin foil improve either the experimental design or the validity of the results.



# CAPT Science Open-Ended Item: *Population Graphs for Taiwan*

## Population Graphs for Taiwan

The graphs below show the population of Taiwan in 2000 and the predicted population of Taiwan in 2050.



Use the graphs to:

- Draw a conclusion regarding the overall population change in Taiwan from 2000 to 2050.
- Describe two factors that may contribute to the predicted population changes from 2000 to 2050.

**Write your answer in your answer booklet.**

# Rubric for *Population Graphs for Taiwan*

Possible Correct Responses:

## Conclusion:

- The population in Taiwan will begin to stabilize over the next 50 years.
- Population growth in Taiwan will slow down over the next 50 years.
- There will be more older people and less younger people in 2050.
- Other acceptable responses

## Factors:

- Reproductive rates could decline some (people of reproductive age having fewer children).
- Longevity could increase (increased survival rate for the elderly).
- Mass immigration to other countries for various reasons.
- Increased access to healthcare or better healthcare provisions.
- Other acceptable responses

## **3-Point Rubric:**

### Score 3

The response draws a valid conclusion regarding the overall population change in Taiwan from 2000 to 2050 and describes two factors that may contribute to the predicted population changes from 2000 to 2050.

### Score 2

The response draws a valid conclusion regarding the overall population change in Taiwan from 2000 to 2050 and describes one factor that may contribute to the predicted population changes from 2000 to 2050.

-or-

The response describes two factors that may contribute to the predicted population changes from 2000 to 2050, but fails to draw a valid conclusion regarding the overall population change.

### Score 1

The response draws a valid conclusion regarding the overall population change in Taiwan from 2000 to 2050, but fails to correctly describe any factors that may contribute to the predicted population changes from 2000 to 2050.

-or-

The response describes one factor that may contribute to the predicted population changes from 2000 to 2050, but fails to draw a valid conclusion regarding the overall population change.

### Score 0

The response provides little or no correct information regarding population changes in Taiwan over the 50-year period.

## **Strand V: Genetics, Evolution and Biodiversity**

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

## Scored Student Responses for Population Graphs for Taiwan

### Score 3

According to the graphs, in ~~the~~ 2050, the majority of the population will be over 40, compared to in 2000 when there were more people in the age 40 or younger.

It is possible that the young population went down because there may be a high infant mortality rate in Taiwan. Also, the birth rate in 2050 could be lower than the birth rate of Taiwan in 2000.

This response provides a valid conclusion regarding the overall population change in Taiwan from 2000 to 2050: "...in 2050, the majority of the population will be over 40, compared to in 2000 when there were more people in the age 40 or younger." Two acceptable factors that may contribute to the predicted population changes from 2000 to 2050 are also given: "high infant mortality rate"; "the birth rate in 2050 could be lower than the birth rate ... in 2000."

## Scored Student Responses for Population Graphs for Taiwan

Score 3

a) The population in Taiwan goes from a generally young population in 2000 to an older population in 2050.

b) This change could be because the birth rate dropped. There are less people at a young age because fewer are being born. The older population could be due to a higher life expectancy.

This response provides a valid conclusion regarding the overall population change in Taiwan from 2000 to 2050: "The population in Taiwan goes from a generally young population in 2000 to an older population in 2050." Two acceptable factors that may contribute to the predicted population changes from 2000 to 2050 are described as well: "the birth rate dropped"; "the older population could be due to a higher life expectancy."

## Scored Student Responses for Population Graphs for Taiwan

### Score 2

b) The two main factors that may contribute to the predicted of population, is the technology and the medicine. The technology help because people invent machines to help people survive. Medicine helps because I prevent sicknesses from killing more and more people.

This response shows no attempt to provide a valid conclusion regarding the overall population change in Taiwan from 2000 to 2050. However, two acceptable factors that may contribute to the predicted population changes from 2000 to 2050 are given: "The technology helps because people invent machines to help people survive. Medicine helps because [it] prevents sicknesses from killing more and more people."

## Scored Student Responses for Population Graphs for Taiwan

Score 2

a = Taiwan 50 years later increased  
its elderly people, but decreased in  
35 year olds and younger.

b = People grow old, so more elderly  
Less people are having kids.

This response provides a valid conclusion regarding the overall population change in Taiwan from 2000 to 2050: "Taiwan fifty years later increased its elderly people, but decreased in 35 year olds and younger." One acceptable factor that may contribute to the predicted population changes from 2000 to 2050 is also described: "Less people are having kids."

## Scored Student Responses for Population Graphs for Taiwan

Score 1

a) In 2050 there will be less people  
from the ages of 0-49 but more  
people from the ages of 49-85+.

b) Everyone in the 0-49 age group will  
be all grown up in 2050 and there  
will be less kids.

A valid conclusion regarding the overall population change in Taiwan from 2000 to 2050 is given: "In 2050 there will be less people from the ages of 0-49, but more people from the ages of 49-85+." However, the response fails to provide two acceptable factors that may contribute to the predicted population changes from 2000 to 2050. It is unacceptable to suggest that children growing up could account for less young people, as is the redundant claim that there are less young people because there are "less kids."

## Scored Student Responses for Population Graphs for Taiwan

Score 1

My conclusion is that in 2050 there is going to be a drastic change. The # of people, ages 0-45, will decrease a lot and the # of people ages 50-85+ will increase

This response provides a valid conclusion regarding the overall population change in Taiwan from 2000 to 2050: "in 2050 there is going to be a drastic change. The number of people, ages 0-45, will decrease a lot and the number of people ages 50-85+ will increase." However there is no attempt to provide two acceptable factors that may contribute to the predicted population changes from 2000 to 2050.



## Scored Student Responses for Population Graphs for Taiwan

Score 0

A It practically doubled in size for both males  
and females.

B more people were being born so that made  
more people for the population.

This response incorrectly indicates that the overall population in Taiwan from 2000 to 2050 will *increase* instead of either stabilizing or decreasing. A factor is provided to explain the increase in population ("more people were being born"). However, it is fundamentally incorrect to conclude that the general population will increase.

## Scored Student Responses for Population Graphs for Taiwan

Score 0

Ⓐ Well, to me the population has grown  
frameradistly.

Ⓑ From 60 years old and up the population  
has grown so much.

This response incorrectly indicates that the overall population in Taiwan from 2000 to 2050 will *increase* instead of either stabilizing or decreasing. There is no attempt to provide any factors that may explain this (incorrect) interpretation.

## CAPT Science Multiple-Choice Questions

1. Over 6 billion people on Earth use water every day, yet Earth's water supply remains relatively constant. This is because \_\_\_\_\_.
- a. the sea level is rising
  - b. water exists in three phases on Earth
  - c. water is constantly recycled by the hydrologic cycle
  - d. global warming melts ice to replace water that is used

### Strand III: Global Interdependence

**Expected Performance:** D 20. Explain how solar energy causes water to cycle through the major earth reservoirs.

2. Two farmers plant different varieties of corn on neighboring farms. Farmer A plants genetically modified corn. Farmer B plants a non-modified variety of corn. What would be farmer B's **primary** concern if she plans to gather seed for next year's crop?
- f. loss of genetic variability in the non-modified variety
  - g. that mutation rates will increase in the non-modified variety
  - h. that insects will only pollinate the genetically modified corn
  - j. unintended transfer of modified genes to her crop by cross-pollination

### Strand IV: Cell Chemistry and Biotechnology

**Expected Performance:** D 35. Explain the risks and benefits of altering the genetic composition and cell products of existing organisms.

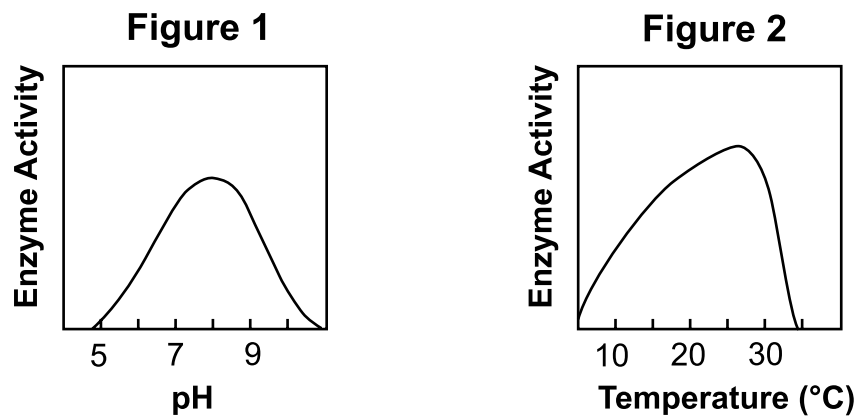
## CAPT Science Multiple-Choice Questions

3. What is accomplished by treating a person who has a bacterial infection with antibiotics?
- immunity to future infections
  - weakening of the person's immune system
  - reduction in the duration and intensity of the infection
  - modification of bacterial DNA to make the bacteria harmless

### Strand IV: Cell Chemistry and Biotechnology

**Expected Performance:** 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.

4. The figures below show the reaction rate of a specific enzyme at different temperatures and different pHs.



What can be concluded about the enzyme?

- The enzyme works best at a pH of 8 and a temperature of 25°C.
- The enzyme only works at a pH of 8 and a temperature of 25°C.
- The enzyme is used up at a pH of 11 and a temperature of 35°C.
- The enzyme works better at a pH of 8 than a temperature of 25°C.

### Strand IV: Cell Chemistry and Biotechnology

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

# CAPT Science Multiple-Choice Questions

## Petroleum-based Polymers vs. Plant-based Polymers

A petroleum-based (inorganic) polymer is commonly used for grocery bags. Recently there has been a push by environmentalists to make grocery bags out of plant-based (organic) polymers.

Students in a science class decided to investigate the strength of the two types of polymers. They obtained one petroleum-based (inorganic) polymer bag and one plant-based (organic) polymer bag of the same size and thickness. They added 100-gram weights to each bag until it broke.

5. What is the independent variable in the investigation?
- a. the size of the bags
  - b. the type of polymer
  - c. the thickness of the bags
  - d. the amount of weight of the bags

### Strand II: Chemical Structures and Properties

**Expected Performance:** D INQ.5 Identify independent and dependent variables, including those that are kept constant and those used as controls.

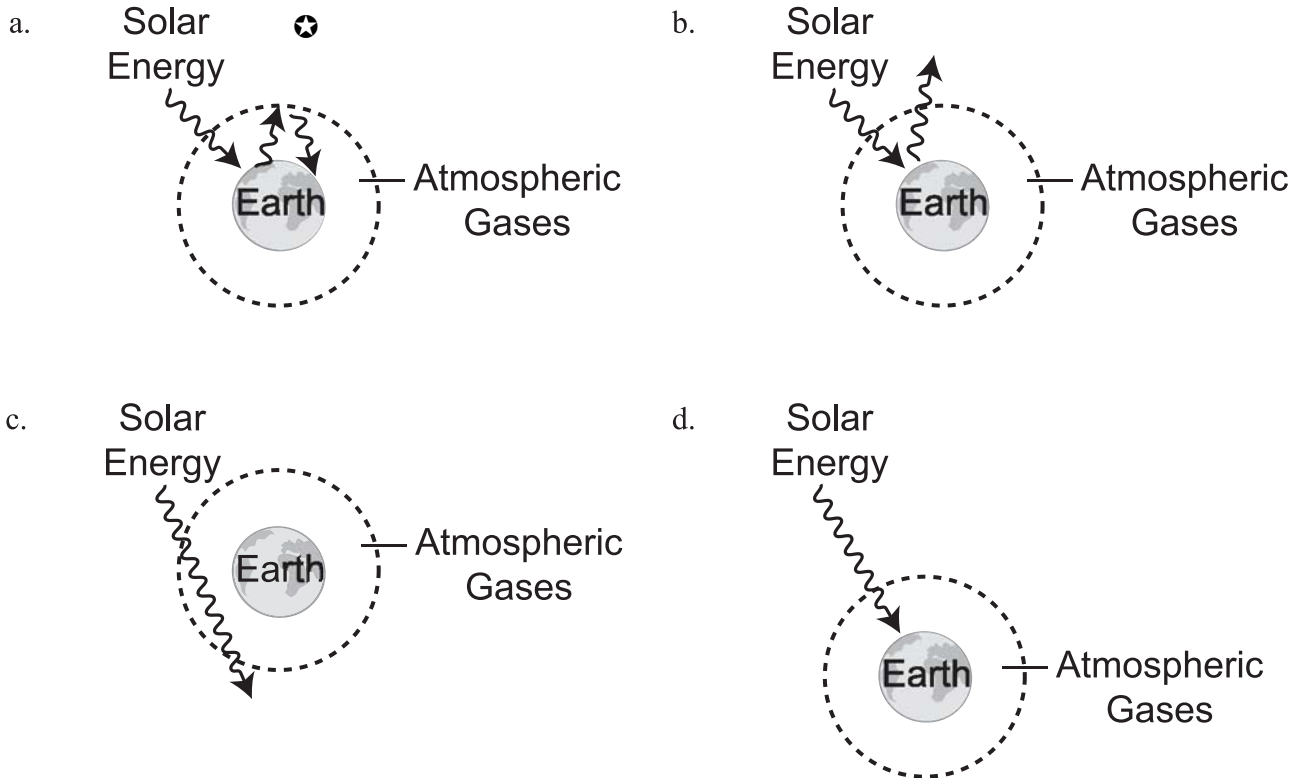
6. The students found that the plant-based polymer grocery bag held 500 grams before breaking and the petroleum-based polymer grocery bag held 600 grams before breaking. In order to increase confidence in their results, the students should repeat the investigation using \_\_\_\_\_.
- f. only plant-based polymer bags
  - g. two other types of polymer bags
  - h. a double thickness of each polymer bag
  - j. both the plant and petroleum polymer bags

### Strand II: Chemical Structures and Properties

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

# CAPT Science Multiple-Choice Questions

7. Which of the following pictures **best** represents the natural greenhouse effect?



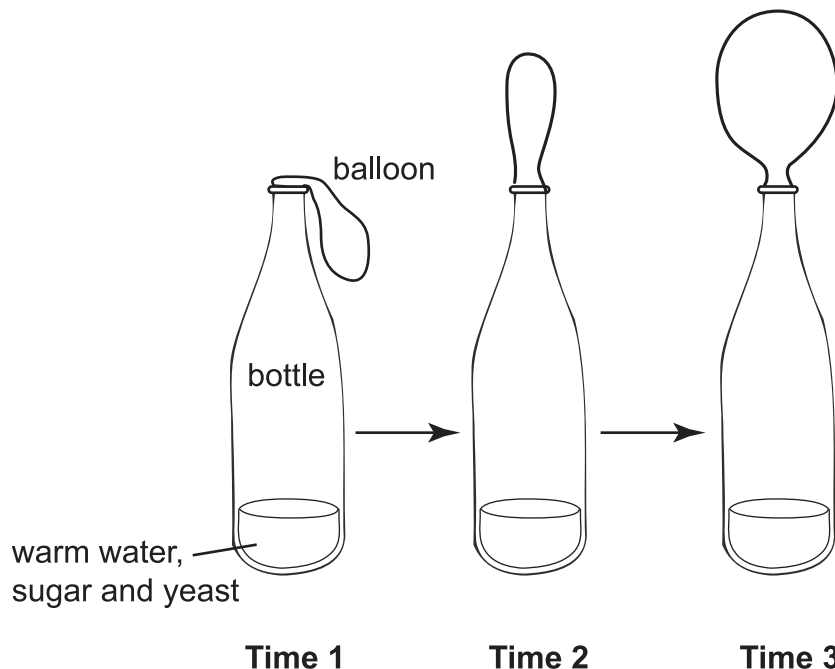
**Strand III:** Global Interdependence

**Expected Performance:** D 23. Explain how the accumulation of carbon dioxide (CO<sub>2</sub>) in the atmosphere increases Earth's "greenhouse" effect and may cause climate changes.

# CAPT Science Multiple-Choice Questions

## Laboratory Investigation

In a laboratory investigation, a student mixes 1 cup of warm water ( $30^{\circ}\text{C}$ ) with 30 grams of sugar and 5 grams of yeast. She pours the mixture into a glass bottle and secures a balloon over the opening. After several minutes, she observes that the balloon begins to inflate, as shown in the picture below.



The student performs two additional trials. In trial 2 she uses water at  $25^{\circ}\text{C}$ , and in trial 3 she uses water at  $20^{\circ}\text{C}$ . She observes that the colder the water, the longer it takes the balloon to inflate.

8. After reviewing her data, the student decides to perform an additional trial at  $35^{\circ}\text{C}$ . She observes that the balloon inflates faster than during the trial in which the  $30^{\circ}\text{C}$  water was used. This additional trial supports which of the following hypotheses?
- f. Warmer temperatures are more favorable for yeast fermentation.
  - g. Yeast require less sugar when maintained at lower temperatures.
  - h. The optimum temperature for yeast fermentation is less than  $35^{\circ}\text{C}$ .
  - j. The time required for fermentation increases with increasing temperature.

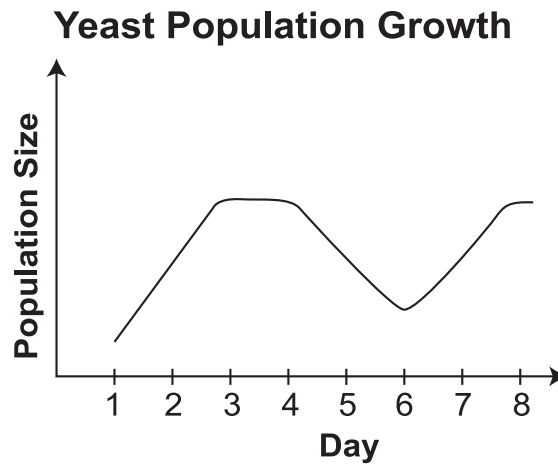
### Strand IV: Cell Chemistry and Biotechnology

**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.

# CAPT Science Multiple-Choice Questions

## Laboratory Investigation (continued)

The graph below shows changes in a yeast population over the course of several days.



9. The yeast were placed on a nutrient dish and allowed to grow. On which day was additional nutrient **most likely** added to the yeast culture?
- a. 3
  - b. 4
  - c. 6
  - d. 7

**Strand V:** Genetics, Evolution and Biodiversity

**Expected Performance:** D INQ.8 Use mathematical operations to analyze and interpret data, and present relationships between variables in appropriate forms.



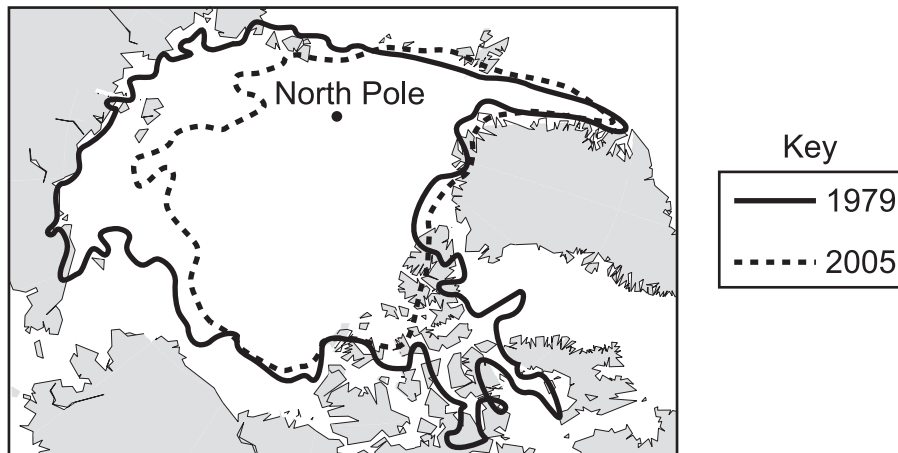
# CAPT Science Multiple-Choice Questions

10. To demonstrate static electricity, a teacher takes an inflated rubber balloon and rubs it on his head. The rubber balloon picks up electrons from his hair, which causes his hair to have a(n) \_\_\_\_\_.
- f. electrical current
  - g. net positive charge ✖
  - h. net negative charge
  - j. buildup of magnetic energy

## Strand I: Energy Transformations

**Expected Performance:** D 4. Explain the relationship among voltage, current, and resistance in a simple series circuit.

11. The picture below shows the extent of summer Arctic Sea ice in 1979 and 2005.



Which hypothesis is **best** supported by the changes in sea-ice coverage?

- a. Earth's climate is gradually warming. ✖
- b. Arctic Sea ice is migrating away from Earth's poles.
- c. Global warming is caused by human activity, not nature.
- d. Global warming occurs only at Earth's poles during the summer.

## 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.

# CAPT Science Multiple-Choice Questions

## Recreation Center Pool

A local recreation center has received funding to build a swimming pool. After construction, the center will be responsible for all costs associated with pool operation. As a result, the center must consider a variety of design options, including pool size, location and heating.

12. What happens to water molecules in a pool as they absorb energy?
- f. The molecules occupy less volume.
  - g. The molecules begin to move more slowly.
  - h. The kinetic energy of the atoms decreases.
  - j. The rate of collision between molecules increases. ⓧ

**Strand I:** Energy Transformations

**Expected Performance:** D 1. Describe the effects of adding energy to matter in terms of the motion of atoms and molecules, and the resulting phase changes.

13. Prior to pool construction, engineers use computer models to compare which of several pool designs require the least amount of energy to be heated. What is the dependent variable in the computer models?
- a. pool size
  - b. pool shape
  - c. pool location
  - d. pool temperature ⓧ

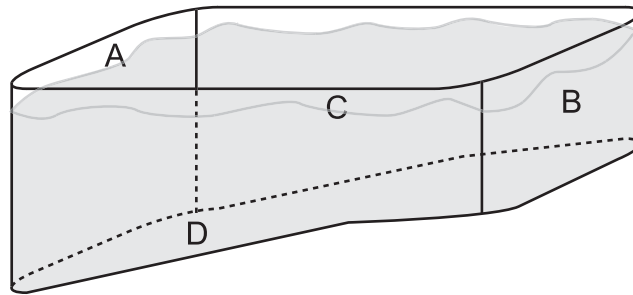
**Strand I:** Energy Transformations

**Expected Performance:** D INQ.5 Identify independent and dependent variables, including those that are kept constant and those used as controls.

## CAPT Science Multiple-Choice Questions

### Recreation Center Pool (continued)

Recreation Center Pool



14. Where should hot water enter the pool to better heat the water?
- f. A
  - g. B
  - h. C
  - j. D

**Strand I:** Energy Transformations

**Expected Performance:** D 2. Explain how energy is transferred by conduction, convection, and radiation.