



Maine  
Department of  
Education

# HIGH SCHOOL

Maine Science Assessment  
Released Items (2023)  
Teacher Version



**New Meridian**

Included in this document are items and their associated stimuli that were operationally administered on the Maine Science Assessment. For each item, the correct answer is provided, along with the Next Generation Science Standards (NGSS) to which it aligns. This includes the disciplinary core idea (DCI), science and engineering practice (SEP), and cross-cutting concept (CCC). In some cases, one of these dimensions may not apply. The number of points the item is worth is also provided.

Use the information from Mine Fires and Microbes to answer **questions 1–5.**

### **Mine Fires and Microbes**

Centralia, Pennsylvania was once a coal mining town and home to more than 2,700 people. Now it has an estimated population of only ten. In 1962, town officials decided to remove a landfill by burning it. Unfortunately, the landfill fire ignited vast reserves of coal in the anthracite coal seams located beneath.

Underground coal seam fires have been burning for almost 60 years. The fires continue to burn under the ground by moving along areas where coal serves as fuel. Scientists are studying the effects the fires have had on the natural environment.

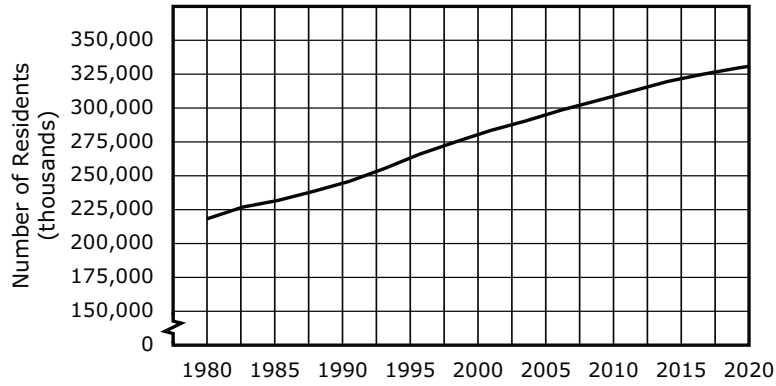


Since the fires began, new populations of organisms—thermophile microbes—have appeared in the soil. Thermophile microbes are visible only through a microscope and survive in extremely hot temperatures. Examples of thermophile microbes include bacteria, algae, and protozoa. Did the appearance of these new microbes likely cause the people to leave Centralia? Where did the thermophile microbes come from?

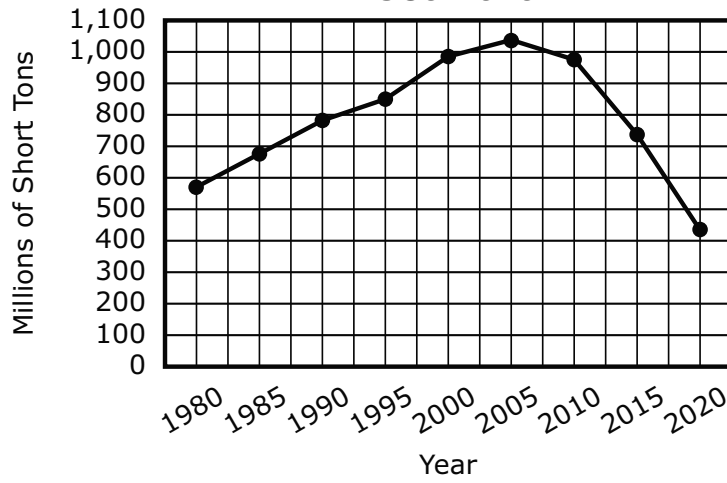
#### **Thermophile Bacteria**



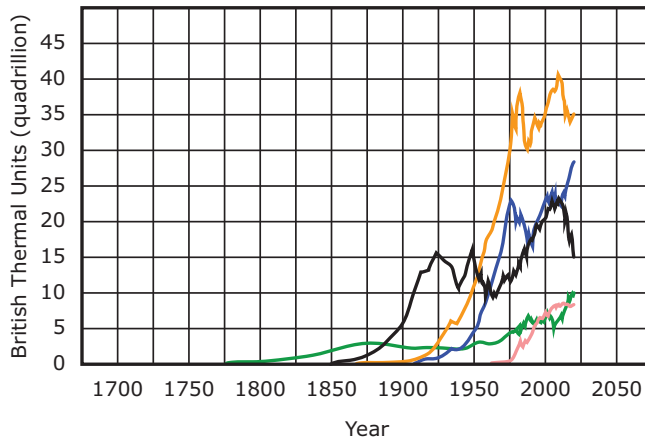
**Resident Population of the United States from 1980-2020**



**United States Coal Consumption 1980-2020**



**Energy Consumption in the United States 1776-2019**



LEGEND		
— petroleum	— natural gas	— renewables
— coal	— nuclear	

## 1. Part A

What was the relationship between the United States population and coal consumption from 2005 to 2020?

Select from the answer bank to complete the statement. Write the letters of the terms in the blanks. Terms may be used more than once.

As the population of the United States \_\_\_A\_\_\_, coal consumption \_\_\_B\_\_\_.

### Answer Bank:

- A. increased
- B. decreased
- C. stayed the same

## Part B

What evidence supports the claim that consumption of energy resources can change based on the needs of the population?

- (A) The population of the United States has increased.
- (B) Petroleum is consumed more than other types of energy.
- (C) In 2020, consumption of coal and renewable energy resources were the same.
- (D) Coal consumption has decreased while natural gas consumption has increased.

### Standards Alignment

Discipline: Earth and Space Science  
NGSS Topic: Human Sustainability

DCI: ESS3.C

Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

SEP4: Analyzing and Interpreting Data

CCC1: Patterns

2. Over the years, the underground coal fires have destroyed animal habitats and caused the relocation of Centralia’s human inhabitants.

**Part A**

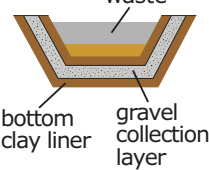


To minimize the impact on the environment, what should town officials have considered before setting the landfill on fire?

1 point

- (A) the smell of the burning trash
- (B) the cost of burning the landfill
- (C)** the locations of the coal seams under the town
- (D) the time it would take to completely burn the trash

**Part B**

Use the information in the chart below to examine other possible solutions.

Solution	Pros	Cons
<p>Clay landfill liner</p>  <p>waste bottom clay liner gravel collection layer</p>	<ul style="list-style-type: none"> <li>Can burn trash without the fire getting to the materials underneath the liner.</li> </ul>	<ul style="list-style-type: none"> <li>Burning trash releases greenhouse gases (carbon dioxide, methane) into the atmosphere.</li> </ul>
<p>Excavation</p> 	<ul style="list-style-type: none"> <li>Quickly removes trash at the site</li> </ul>	<ul style="list-style-type: none"> <li>Trash needs to be deposited at another location.</li> </ul>
<p>Cover the landfill with vegetation and soil</p> 	<ul style="list-style-type: none"> <li>Reclaimed land can be reused for parks and/or wildlife habitats.</li> </ul>	<ul style="list-style-type: none"> <li>Only lasts 50 to 100 years</li> <li>Can be disturbed by earthquakes or sinking land underneath.</li> </ul>

Which solution to remove the landfill would have had the least, the greatest, or no negative impact on the environment? Match each solution with its level of impact on the environment. Write the letter of the solution in the box in front of its impact.

Solution	Level of Impact
<b>C</b>	Least negative impact
<b>B</b>	No overall impact
<b>A</b>	Greatest negative impact

**Answer Bank:**

- A. clay liner
- B. excavation
- C. cover with natural vegetation and soil

See next page for standards alignment

1 point for all 3 correct solutions

## **Standards Alignment for Item 2**

Discipline: Earth and Space Science

NGSS Topic: Human Sustainability

DCI: ESS3.C

Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

SEP6: Constructing Explanations and Designing Solutions

CCC3: Scale, Proportion, and Quantity

3. Microbes that live in soil, like those in Centralia, can become active or dormant. Dormant thermophile microbes, in a state similar to hibernation, can return to an active state when conditions are right in the environment.

How did human activity contribute to the thermophile microbes in Centralia returning to an active state? Write the numbers 1 through 4 in the table to show the order of events.

1 point for all  
4 in the  
correct order

Order	Event
4	Thermophile microbes returned to an active state.
1	Town officials burned a landfill.
3	The temperature of the soil increased.
2	The coal seam fire started.

### **Standards Alignment**

Discipline: Earth and Space Science  
NGSS Topic: Human Sustainability

DCI: ESS3.B

Natural hazards and other geologic events have shaped the course of human history; they have significantly altered the sizes of human populations and have driven human migrations.

SEP6: Constructing Explanations and Designing Solutions

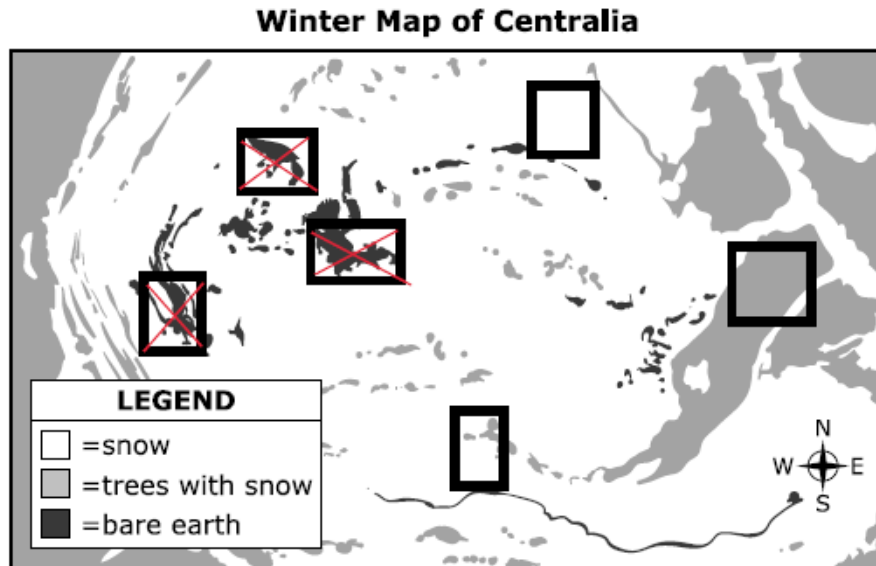
CCC2: Cause and Effect



4. The coal fires in Centralia are located in underground coal seams. One way to detect the location of the fires is to measure the temperature of the soil above. To date, the highest recorded temperature of the soil in Centralia is 1350° Fahrenheit. When snow covers the soil, it is easier to detect the locations of the fires.

Which of the outlined areas can thermophile microbes **most likely** be found? Mark areas on the map with an X to indicate where you predict thermophile microbes to be.

1 point for all 3 correct spots and no incorrect spots



### **Standards Alignment**

Discipline: Earth and Space Science

NGSS Topic: Human Sustainability

DCI: ESS3.C

The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.

SEP3: Planning and Carrying Out Investigations

CCC1: Patterns

5. Scientists studying the thermophile microbes in Centralia are hopeful that the appearance of thermophile bacteria can lead to the discovery of new antibiotics. Antibiotics are medicines used to treat infections caused by bacteria.

1 point

What evidence supports the idea that changing environments can be beneficial to some organisms?

- A Some organisms have an adaptation that allows them to thrive in extreme environments.
- B Some organisms can survive in any extreme environment because they do not require oxygen.
- C Organisms use natural selection to develop characteristics that allow them to survive in extreme environments.
- D Organisms with characteristics strong enough to overpower weaker organisms can survive in extreme environments.

### **Standards Alignment**

Discipline: Earth and Space Science

NGSS Topic: Human Sustainability

DCI: ESS3.C

The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.

SEP6: Constructing Explanations and Designing Solutions

CCC2: Cause and Effect

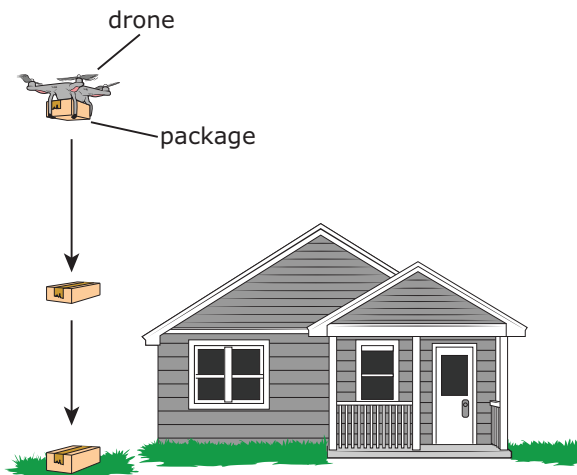
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Use the information from Drone Delivery to answer **questions 6–7**.

## Drone Delivery

A package delivery company plans to deliver packages using drones. The packages will contain clothing, tightly packed and with no empty space. Since many areas do not allow delivery drones to fly lower than 19.60 m from the ground when delivering packages, the packages must be dropped to the ground.

The company had conducted a survey asking customers what their biggest concern is with drone delivery, and customers overwhelmingly said they worried that packages would arrive damaged. Therefore, the company’s engineers must determine the best way to deliver packages by drone. The company plans a test run to ensure that delivery by drone is feasible and can result in little or no damage to packages.



Engineers conduct tests to study factors that may affect the amount of damage to packages dropped from a height of 19.60 m. In each test, the package lands with its bottom to the ground. There is little to no wind, because the company plans to deliver packages by drone only in calm weather. The tables show their data.

Package	Mass (g)	Time Dropped	Time Landed	Shape of Package
A	2163	8:32:04 a.m.	8:32:06 a.m.	
B	1100	10:00:00 a.m.	10:00:02 a.m.	
C	1100	10:34:45 a.m.	10:34:47 a.m.	
D	970	1:05:04 p.m.	1:05:06 p.m.	
E	2750	3:22:49 p.m.	3:22:51 p.m.	

The engineers measure the distance a package travels over time from the drone to the ground. They record the data in a table.

Time (s)	0	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00
Distance (m)	0	0.31	1.22	2.76	4.90	7.66	11.03	15.00	19.60

6. The engineers know that Newton's Second Law of Motion relates the force and mass of an object to its acceleration using the equation  $F = ma$ . Engineers evaluate the force applied to each package and determine the acceleration to equal  $9.8 \frac{m}{s^2}$ .

**Part A**

What does  $9.8 \frac{m}{s^2}$  represent?

- (A) force
- (B) speed
- (C) gravity
- (D) distance

**Part B**

Which package has the greatest force between Earth and itself before it is dropped?

- (A) Package A
- (B) Package B
- (C) Package C
- (D) Package D
- (E) Package E

**Standards Alignment**

Discipline: Physical Science

NGSS Topic: Forces and Interactions

DCI: PS2.A

Newton's second law accurately predicts changes in the motion of macroscopic objects.

SEP5: Using Mathematics and Computational Thinking

CCC3: Scale, Proportion, and Quantity

7. The engineers calculate the momentum of the packages using the equation  $p = mv$ . Knowing the momentum can help engineers determine which package will likely sustain the most damage when it hits the ground.

**Part A**

Which package has the greatest momentum?

1 point

- (A) Package A
- (B) Package B
- (C) Package C
- (D) Package D
- (E) Package E

**Part B**

Why is the package from Part A expected to sustain the most damage? Use the equation  $p = mv$  to explain.

1 point

See rubric on the next page

**Standards Alignment**

Discipline: Physical Science

NGSS Topic: Forces and Interactions

DCI: PS2.A

Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. In any system, total momentum is always conserved.

SEP5: Using Mathematics and Computational Thinking

CCC3: Scale, Proportion, and Quantity

## Drone Delivery Rubric

Points	Qualities of the Student Response
1	<p>Response must explain momentum by identifying the relationship between mass/momentum/damage.</p> <p>Package E will sustain the most damage because it has greater mass which results in more momentum.</p> <p>[Note: Package E uses the least amount of air resistance.]</p> <p><b><u>Example Student Response:</u></b></p> <p>Momentum is equal to the mass times velocity which means that the greater the mass of the package, the greater the momentum. The greater the momentum, the possibility of the package becoming damaged increases.</p> <p><b><u>Note:</u></b> A 1pt response may not include any errors or flawed logic.</p>
0	<p>The response demonstrates minimal understanding of the prompt. The response is incorrect or contains some correct work that is irrelevant to the skill or concept being measured.</p> <ul style="list-style-type: none"><li>• e.g., describes the presence of a relationship between mass/momentum but doesn't describe the relationships (i.e., as one increases, the other increases)</li><li>• e.g., identifies an incorrect package (something other than Package E)</li></ul>