

## Answer Key and National Student Data for NAEP Cracking Concrete Interactive Science Task

In this 20-minute task, students investigate what happens to the volume of water when it freezes. Then students use the results of their investigations to predict and test what will happen when water freezes in the cracks of a concrete sidewalk.

### Question 1

Record the volume of the water in milliliters (mL).

Your answer:

Sample Complete Student Response: 100mL

#### Scoring Guide

##### Complete:

Student response states 100 (mL). Units are not required, but response is not credited for an incorrect unit that refers to a non-volume unit of measure.

Unsatisfactory/Incorrect: Student response is inadequate or incorrect.

Percentage of fourth-grade students in each response category: 2009

Complete	Unsatisfactory/Incorrect	Omitted
83	14	3

NOTE: Detail may not sum to totals because of rounding.

### Question 2

At 7 degrees Celsius, the water is a liquid. What do you think will happen to the water if the temperature drops to -1 degree Celsius?

Your answer:

Sample Complete Student Response: I think the water will freeze into a solid.

#### Scoring Guide

##### Complete:

Student response indicates that the water will get colder (freeze) and change from liquid (water) to solid (ice).

##### Partial:

Student response indicates that the water will get colder (freeze), but does not describe the change from liquid (water) to solid (ice).

OR

Student response describes the change from liquid (water) to solid (ice), but does not indicate that the water will get colder (freeze) to become ice.

##### Unsatisfactory/Incorrect:

Student response is inadequate or incorrect.

Percentage of fourth-grade students in each response category: 2009

Complete	Partial	Unsatisfactory/Incorrect	Omitted
7	61	28	3

NOTE: Detail may not sum to totals because of rounding.

### Question 3

Record the volume of the ice in milliliters (mL).

Your answer:

Sample Complete Student Response: 110

#### Scoring Guide

##### Complete:

Student response states 110 (mL). Units are not required, but response is not credited for an incorrect unit that refers to a non-volume unit of measure.

##### Unsatisfactory/Incorrect:

Student response is inadequate or incorrect.

Percentage of fourth-grade students in each response category: 2009

Complete	Unsatisfactory/Incorrect	Omitted
28	68	4

NOTE: Detail may not sum to totals because of rounding.

### Question 4

A student recorded the following data for the water and the ice:

Water

Temperature: 7 degrees Celsius

Volume: 100 mL

Ice

Temperature: -1 degree Celsius

Volume: 110 mL

Describe what happened to the volume when the water changed to ice.

Your answer:

By how much did the volume change?

Your answer:

Sample Complete Student Response:

Description: When the water turned to ice the volume increased by 10(mL).

Volume change: 10(mL)

#### Scoring Guide

##### Complete:

Student response provides a correct explanation that consists of two parts:

- Indicates an increase in volume when the water changed to ice.
- Indicates the change in volume was 10 (mL). Units are not required, but response is not credited for an incorrect unit that refers to a non-volume unit of measure.

##### Partial:

Student response addresses one part of a correct explanation.

##### Unsatisfactory/Incorrect:

Student response is inadequate or incorrect.

Percentage of fourth-grade students in each response category: 2009

Complete	Partial	Unsatisfactory/Incorrect	Omitted
40	29	30	1

NOTE: Detail may not sum to totals because of rounding.

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## Question 5

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A student recorded the following data for the water and the ice:

Water

Temperature: 7 degrees Celsius

Volume: 100 mL

Ice Temperature: -1 degree Celsius

Volume: 110 mL

If you turn the ice back into water, what do you think will happen to the volume?

- A. The water will take up less volume than the ice.
- B. The water will take up the same volume as the ice.
- C. The water will take up more volume than the ice.

**Your answer:**

Explain why you think this. Use the data to support your explanation.

**Your answer:**

**Sample Complete Student Response:**

Selection: (A) The water will take up less volume than the ice.

Explanation: Because the water took up more space when frozen than regular. When you put the water back to 7 degrees Celsius, it went back to 100 mL.

**Scoring Guide**

**Complete:**

Student response selects (A) The water will take up less volume than the ice, and provides a correct explanation referring to the data and/or the experiment. Response compares the volumes of ice (110 mL) and water (100 mL) and indicates the water will return to its original volume (100 mL).

**Essential:**

Student response selects (A), and compares the volumes of ice and water indicating the volume of the water will decrease, but does not specify that the water will return to its original volume.

**Partial:**

Student response selects (A), and compares the volumes of ice and water or indicates the water will return to its original volume.

OR

Student response makes an incorrect selection, but provides a correct explanation supporting correct choice (A).

**Unsatisfactory/Incorrect:**

Student response is inadequate or incorrect.

**Percentage of fourth-grade students in each response category: 2009**

Complete	Essential	Partial	Unsatisfactory/Incorrect	Omitted
3	8	43	46	1

NOTE: Detail may not sum to totals because of rounding.

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## Question 6

What happened to the volume when the ice changed back to water?

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

**Your answer:**

Explain how you know. Use your data to support your explanation.

**Your answer:**

**Sample Complete Student Response:**

Selection: (B)The volume decreased.

Explanation: When it was ice it went to 110mL, but when it got heated up it decreased back to 100mL.

**Scoring Guide**

**Complete:**

Student response selects (B) The volume decreased, and provides a correct explanation indicating that the volume (of the ice) decreased from 110 (mL) to 100 (mL). (Water volume was 10 (mL) less than the volume of the ice.)

**Essential:**

Student response selects (B), and provides a general explanation indicating the volume decreased when the ice melted, but refers to partial data or no data for support (or provides an inaccurate reading of the volume of ice and/or water after the ice melted).

**Partial:**

Student response does not select (B), but provides an explanation that includes valid data supporting correct choice (B).

**Unsatisfactory/Incorrect:** Student response is inadequate or incorrect.

**Percentage of fourth-grade students in each response category: 2009**

Complete	Essential	Partial	Unsatisfactory/Incorrect	Omitted
15	25	8	51	#

# Rounds to zero.  
NOTE: Detail may not sum to totals because of rounding.

## Question 7

During rainy weather, water fills small sidewalk cracks like the ones shown on the left.

The thermometer shows that the temperature is 7 degrees Celsius.

If the sidewalk temperature drops to -1 degree Celsius, predict what will happen to the cracks in the sidewalk.

- A. The cracks will become smaller.
- B. The cracks will remain the same size.
- C. The cracks will become larger.

**Your answer:**

Based on your investigations of water and ice, explain why you think this.

**Your answer:**

**Sample Complete Student Response:**

Selection C. The cracks become larger.

Explanation: Since the ice gets bigger in volume when it is frozen, then if water got in there and froze then it would get bigger and so would the crack.

**Scoring Guide**

**Complete:**

Student response selects (C) The cracks will become larger, and provides a correct explanation that consists of two parts:

- Indicates the water will change to solid (form ice, freeze).
- Indicates that water expands (volume increases, pushes out) when it freezes.

**Essential:**

Student response selects (C), and addresses one part of a correct explanation.

**Partial:**

Student response does not select (C), but provides a correct explanation supporting correct choice (C).

**Unsatisfactory/Incorrect:**

Student response is inadequate or incorrect.

**Percentage of fourth-grade students in each response category: 2009**

Complete	Essential	Partial	Unsatisfactory/Incorrect	Omitted
24	16	8	51	1

NOTE: Detail may not sum to totals because of rounding.

## Question 8

The temperature at night dropped to -1 degree Celsius several times in the winter.  
The picture shows the cracks in the sidewalk at the end of the winter.

Describe what happened to the cracks in the sidewalk.

Your answer:

Explain why that happened to the cracks.

Your answer:

**Sample Complete Student Response:**

Part A: It grew larger in width and length.

Part B: It happened because ice takes up more room than water.

**Scoring Guide**

This item was scored in two parts:

Part A describes what happened.

Part B explains why it happened.

**Part A:**

**Complete:**

Student response describes that the cracks became bigger and spread (created more cracks) to other parts of the sidewalk.

**Partial:** Student response provides a partial description including that the cracks became bigger or that the cracks spread.

**Unsatisfactory/Incorrect:**

Student response is inadequate or incorrect.

**Part B:**

**Complete:**

Student response indicates understanding that when the water (liquid) changed to solid (ice) the ice expanded (volume increased), which led to cracks.

**Partial:**

Student response indicates that the water (liquid) changed to solid (ice) without indicating that the ice expanded.

**Unsatisfactory/Incorrect:**

Student response is inadequate or incorrect.

**Composite Score:**

Student response received one of four possible composite scores (Complete, Essential, Partial, Unsatisfactory/Incorrect) based on the student's combined performance on Parts A and B of the item. For example, a student response Complete for Part A, and Partial for Part B received a composite score of Essential.

<b>Composite score</b>	<b>Part A</b>	<b>Part B</b>
Complete	Complete	Complete
<b>Essential</b>	Complete	Partial
	Partial	Complete
	Partial	Partial
	Complete	Unsatisfactory/Incorrect
	Unsatisfactory/Incorrect	Complete
<b>Partial</b>	Partial	Unsatisfactory/Incorrect
	Unsatisfactory/Incorrect	Partial
<b>Unsatisfactory/Incorrect</b>	Unsatisfactory/Incorrect	Unsatisfactory/Incorrect

Percentage of fourth-grade students in each response category: 2009

Complete	Essential	Partial	Unsatisfactory/Incorrect	Omitted
1	34	53	11	#
# Rounds to zero. NOTE: Detail may not sum to totals because of rounding.				

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## Question 9

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What could the city do to stop the cracks from getting larger in future winters?

Your answer:

**Sample Complete Student Response:**

The city could stop the cracks from getting larger by filling them in with cement.

### Scoring Guide

#### Complete:

Student response describes a plausible solution that would reduce the amount of water getting into the cracks (or would delay freezing inside the cracks or would add space (joints) to allow for the expansion of water when it freezes).

#### Partial:

Student response describes a solution that is general or not plausible, but has the correct goal to stop the cracks from getting larger by reducing the amount of water filling or freezing in the cracks or by adding space to allow for expansion.

#### Unsatisfactory/Incorrect:

Student response is inadequate or incorrect.

Percentage of fourth-grade students in each response category: 2009

Complete	Partial	Unsatisfactory/ Incorrect	Omitted
26	46	26	#
# Rounds to zero. NOTE: Detail may not sum to totals because of rounding.			

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009 Science Assessment.