http://www.nationsreportcard.gov/science_2009/ict_tasks.asp

Answer Key and National Student Data for NAEP Bottling Honey Interactive Science Task

In this 20-minute task, students investigate how four different liquids behave when they are poured and how temperature affects the flow rates of the liquids. Then students determine the best temperature range for bottling honey that will take the least amount of time while using as little energy as possible.

Question 1

Which liquid flows most slowly at 20 degrees Celsius?

A. Corn syrup
B. Honey
C. Water
D. Olive oil

Your answer:

Correct answer: B

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

Choice A	**Choice B**	Choice C	Choice D	Omitted
1	**94**	3	1	1

This task comes from the National Assessment of Educational Progress (NAEP), commonly referred to as "the Nation's Report Card." NAEP is the largest nationally representative and continuing assessment of what America's students know and can do in various subject subjects. For more information, go to http://www.nationsreportcard.gov/.

Question 2

Which liquid has the same flow rate at 30 degrees Celsius as water at 30 degrees Celsius?

A. Olive oil
B. Corn syrup
C. Honey

Your answer:

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

Your answer:

Sample Complete Student Response:

Corn syrup and water have the same flow rate at 30 degrees Celsius. I know that because when I set the temperatures at 30 I dropped the steel ball and when the simulation was over, I checked the time at the bottom and the only time that was the same as water was corn syrup, which was 0.2.

Scoring Guide

Complete:
Student response selects (B) Corn syrup, and provides a correct explanation that indicates when the liquids are at 30°C, the time for the ball to reach the bottom of the cylinder is the same for corn syrup and water (longer for honey and olive oil), and includes the drop time of 0.2 seconds for both corn syrup and water.

Essential:
Student response selects (B) Corn syrup, and indicates when the liquids are at 30°C the time for the ball to reach the bottom of the cylinder is the same for corn syrup and water (longer for honey and olive oil).

OR

Student response selects (B) Corn syrup, and indicates the drop time of 0.2 seconds for both corn syrup and water.

Partial:
Student response selects (B) Corn syrup, and provides incomplete, but correct data supporting choice (B).

OR

Student response selects (B) Corn syrup, and describes the general procedure for the investigation that indicates testing the liquids at 30°C and measuring the drop times.

Unsatisfactory/Incorrect:
Student response is inadequate or incorrect.

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

Complete	Essential	Partial	Unsatisfactory/Incorrect	Omitted
20	34	8	37	#

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

Question 3

Describe the steps you will take to investigate which liquids flow more quickly at a higher temperature than at a lower temperature.

Your answer:

Sample Complete Student Response:

For each liquid I will put it at the highest temperature I can then I will drop the metal ball in and record how fast it flowed through the liquid. then I will do the same once again but instead of at the highest temperature it will be at the lowest temperature.

Scoring Guide

Complete:
Student response describes the essential components of an investigation that includes comparing the drop times of the balls through each of the liquids at both higher and lower temperatures.

Essential:
Student response describes an investigation that includes comparing the drop times of the balls through each of the liquids at only one temperature.

OR

Student response describes an investigation that includes comparing the drop times of the balls through only one liquid at higher and lower temperatures.

OR

Student response describes an investigation that includes testing each of the liquids at higher and lower temperatures.

Partial:
Student response describes an investigation that includes comparing the drop times of the balls through the liquids.

OR

Student response describes an investigation that includes testing a liquid at higher and lower temperatures.

OR

Student response describes an investigation that includes testing all four liquids at only one temperature.

Unsatisfactory/Incorrect:
Student response is inadequate or incorrect.

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

Complete	Essential	Partial	Unsatisfactory/Incorrect	Omitted
13	36	26	22	2
NOTE: Detail may not sum to totals because of rounding.				

Question 4

Which liquid flows more quickly at a higher temperature than at a lower temperature? Select all that apply.

A. Corn syrup
B. Honey
C. Water
D. Olive oil

Your answer:

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

Your answer:

Sample Complete Student Response::

Selection: (A) Corn syrup, (B) Honey, (D) Olive oil

Explanation:

I know because I tested each, every substance, except the water, flowed more quickly at a higher temperature than a lower one. The steel ball fell in 0.7 seconds in the corn syrup when the temperature 20°C. When it was raised to 50°C, the ball took 0.2 seconds to flow through the syrup. In the honey, at 20°C, the ball took 11.0 seconds to drop, while it only took 0.3 seconds when raised to 50°C. the water stayed the same, regardless of the temperature. At 20°C and 20°C, it took 0.2 seconds for the ball to drop. While at 20°C, the steel ball took 0.9 seconds to drop through the olive oil. When it was raised to 50°C, it took 0.6 seconds. this shows that, minus the water, the substances flowed more quickly in each substance when the temperature was raised.

Scoring Guide

Complete:
Student response selects the three correct choices (A) Corn syrup, (B) Honey, (D) Olive oil, and provides an explanation that indicates the drop times (speed, rate) of the balls through the liquids are slower at lower temperatures and faster at higher temperatures, using valid data for support.

Essential:
Student response selects the three correct choices, and includes an explanation that compares the drop times at higher and lower temperatures. Selection does not include (C).

OR

Student response selects the three correct choices, but provides a general description of the procedure that includes testing the liquids at high and low temperatures and comparing the drop times with no reference to valid data. Selection does not include (C).

OR

Student response selects two correct choices, and includes an explanation that compares the drop times at higher and lower temperatures, using valid data for support. Selection does not include (C).

Partial:
Student response selects two correct choices, and includes an explanation that compares the drop times at higher and lower temperatures. Selection does not include (C).

OR

Student response selects one correct choice, and includes an explanation that compares the drop times at higher and lower temperatures, using valid data for support. Selection does not include (C).

OR

Student response selects one or two correct choices, and provides a general description of the procedure with no reference to valid data. Selection does not include (C).

OR

Student response selects (C) with other correct choice(s), and provides an explanation based on their investigation that supports their correct choice(s). Response does not include contradictory information.

Unsatisfactory/Incorrect:
Student response is inadequate or incorrect.

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

Complete	Essential	Partial	Unsatisfactory/Incorrect	Omitted
5	17	29	49	#

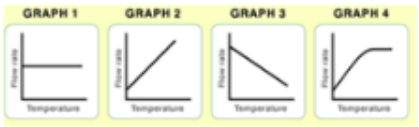
Rounds to zero.
NOTE: Detail may not sum to totals because of rounding.

Question 5

A food processing company bottles honey. They want to bottle the honey as quickly as possible while using the least amount of energy to heat the honey.

Now use the simulation to investigate the relationship between the temperature and the flow rate of honey over a range of temperatures.

Which graph shown below best represents your results?



A. Graph 1
B. Graph 2
C. Graph 3
D. Graph 4

Your answer:

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

Your answer:

Sample Complete Student Response:

Selection: (D) Graph 4

Explanation: I saw that every time I put the temperature higher for the honey the steel ball went to the bottom faster. Once I got to 55 degrees Celsius I saw that the steel ball stayed at .2 time no matter how high the temperature got.

Scoring Guide

Complete:
Student response selects (D) Graph 4, and provides a correct explanation to support Graph 4 based on valid data from their investigation that includes testing honey over the complete range of temperatures. Valid data show that the ball drops faster as the temperature of honey increases to 55°C, above which the drop time does not change (stays at 0.2 seconds).

Essential:
Student response selects (D) Graph 4, and provides a correct explanation to support Graph 4 based on valid, but incomplete data from their investigation. Explanation is based on testing honey over part of the temperature range.

Partial:
Student response selects (B) Graph 2, and provides an explanation based on valid, but incomplete data from their investigation; explanation is based on testing honey at lower temperatures up to 55°C or low and high temperatures, which supports Graph 2.

OR

Student response makes an incorrect selection, but provides an explanation based on the results of testing honey over the complete range of temperatures supporting correct choice (D).

Unsatisfactory/Incorrect:
Student response is inadequate or incorrect.

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

Complete	Essential	Partial	Unsatisfactory/Incorrect	Omitted
8	10	23	58	#

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

Question 6

The food processing company wants to bottle the honey as quickly as possible while using the least amount of energy to heat the honey. Assume that the honey has already been pasteurized.

Which temperature range is best to use for bottling the honey to meet both of these conditions?

A. 25 - 35 degrees Celsius
B. 40 - 50 degrees Celsius
C. 55 - 65 degrees Celsius
D. 70 - 80 degrees Celsius

Your answer:

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

Your answer:

Sample Complete Student Response:

Selection: C

Explanation: I chose C because at 55 degrees Celsius and higher, it stays the same of 0.2 seconds. If it is a lower temperature it will take longer to pour the honey into bottles. If the temperature is any higher the flow won't get faster, so you will be just wasting extra amounts of energy.

Scoring Guide

Complete:
Student response selects (C) 55-65°C, and provides a correct explanation based on valid data from their investigation that addresses the two conditions; bottling the honey as quickly as possible, and using the least amount of energy. Explanation demonstrates understanding that the flow rate of honey increases with temperature reaching a maximum flow rate around 55°C, so heating the honey to higher temperatures would waste energy.

Essential:
Student response selects (C) 55-65°C, and provides an explanation that addresses one condition.

OR

Student response makes an incorrect selection, and provides an explanation based on data from their investigation that indicates why the choice selected is better than the other choices in terms of the two conditions.

Partial:
Student response selects (C) 55-65°C, and provides an explanation that does not specifically address either of the two conditions, but provides valid data from their investigation showing a shorter drop time as the temperature increases, or a constant drop time of 0.2 from 55°C to 80°C.

OR

Student response selects (C) 55-65°C, and provides a general procedure based on their investigation that indicates measuring the drop times of the ball through honey at different temperatures.

OR

Student response makes an incorrect selection, and provides an explanation based on valid data from their investigation that addresses one condition.

Unsatisfactory/Incorrect:
Student response is inadequate or incorrect.

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

Complete	Essential	Partial	Unsatisfactory/Incorrect	Omitted
4	15	15	66	#

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.