Teacher Version

Delaware Science Assessment Prototype: Grade 8 Integrative Item Cluster

Prepared for the Delaware Department of Education
by WestEd

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Grade 8 Integrative Item Cluster

Background:

The Delaware Department of Education engaged with WestEd to design and develop sample tasks to measure the Next Generation Science Standards (NGSS). These tasks were administered to Delaware students as part of a process to evaluate the tasks' effectiveness at measuring all three dimensions of the NGSS—Science and Engineering Practices (SEPs), Disciplinary Core Ideas (DCIs), and Crosscutting Concepts (CCC). These tasks were revised based on the data collected during the research period, and are now available to Delaware educators as sample NGSS-aligned assessments for use in their classrooms.

Recommendations on how to use the Integrative Item Cluster Prototype:

The following Integrative Item Cluster (IIC) is designed to elicit evidence of a student's understanding and ability to apply specific science skills in a real-world context. Each IIC is designed around a central phenomenon and requires students to use and apply all three dimensions to respond to questions associated with a common stimulus. ***It is recommended that this IIC be administered following the instruction of Performance Expectations (PEs) MS-PS3-4, and MS-PS3-5.***

This IIC assesses a student's ability to apply science practices that are related to PEs MS-PS3-4 and MS-PS3-5. Only the specific SEPs of *Planning and Carrying Out Investigations* and *Engaging in Argument from Evidence* are measured as part of this IIC. Either SEP may be used with an item aligning to either PE to more closely mirror instruction. In this way, the IICs prepare students to ***integrate*** and ***apply*** knowledge and skills from specific PEs at the end of a relevant unit of instruction, an important expectation of Delaware's Comprehensive Science Assessment System.

This IIC prototype is provided as a formative assessment tool and is not meant to demonstrate the exact mode or content that will appear in Delaware's future assessments. Rather, we invite teachers to explore the use of IICs in their classroom to better understand the nature of NGSS assessment.

Materials:

Student Version PDF: This version is available to download and print in order to administer the IIC prototype directly to students. All student responses can be captured on this hard copy, **OR** a set of class copies can be printed and student responses can be captured on a separate piece of paper. The IIC is designed to be self-explanatory and should require little instruction on the part of the teacher or proctor. The suggested time to complete the IIC is 20 minutes.

Teacher Version PDF: In addition to the content contained in the student version, the teacher version provides alignment information in gray metadata boxes. Scoring information (the key) is included in the metadata or is provided as a detailed rubric/scoring information section below items where relevant. Keys and recommended point values for each question are provided in the metadata tables (10 points total for the IIC), but point values can be adjusted based on overall class performance.

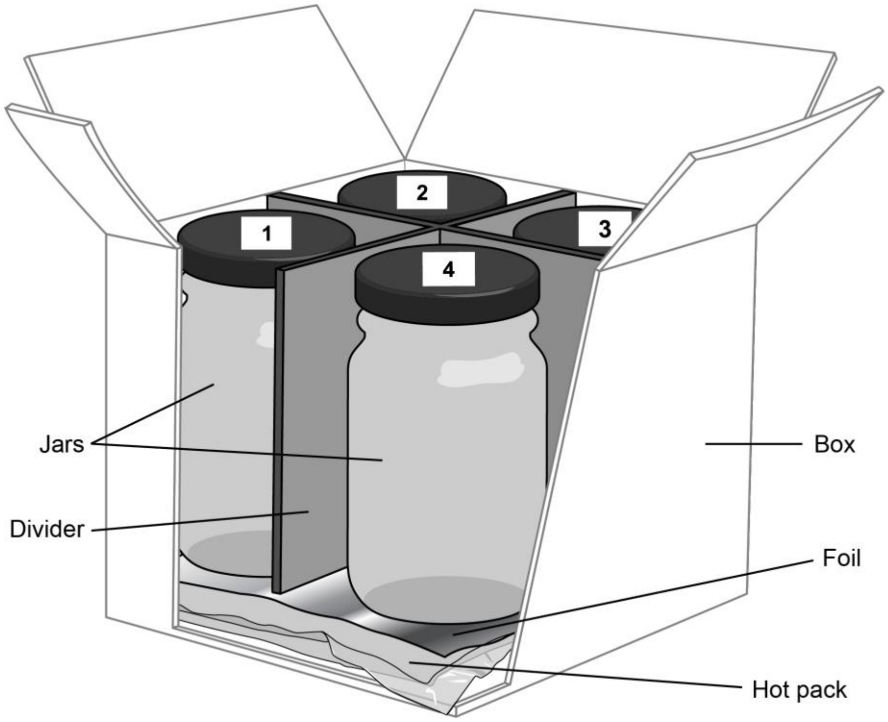
These resources are available for public use and we encourage you to share them freely. Questions can be sent to april.mccrae@doe.k12.de.us.

Alignment Information for the Grade 8 IIC
PE/PE Bundle: **MS-PS3-4**: Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. **MS-PS3-5**: Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.
Dimensions: SEP: INV, ARG **DCI:** PS3.A, PS3.B **CCC:** SPQ, E/M
Focus: Temperature and Kinetic Energy
Phenomenon: Hot packs affect the temperature of their surroundings. The mass of water affects the temperature change caused by a hot pack**.**

Hot Pack Investigation #1

A student investigated how volume affects how the temperature of a substance changes by following these steps:

- Place an instant hot pack in the bottom of a cardboard box.
- Put a layer of aluminum foil on top of the hot pack.
- Place a tight-fitting cardboard divider in the box on top of the foil to create four sections.
- Add a different volume of room temperature water to each jar.
- Place one jar in each section, as shown in the diagram below.



The cardboard box was sealed and the water was allowed to heat for 10 minutes. After 10 minutes, the student removed the four jars and immediately recorded the temperature of the water in each jar.

Item: 1	**Item Format: CR**
Grade: 8	
PE/PE Bundle: MS-PS3-4	**Total Points:** 0
Dimensions: SEP: INV **DCI:** PS3.A; PS3.B	**Key(s):** not scored
Focus: How does mass affect temperature change?	

Question 1. In the space below, make a prediction to answer these two scientific questions:

1. How will thermal energy be transferred between the instant hot pack and the water in each jar?
2. How will the temperature of the water in each jar change during the 10 minutes the box is sealed?

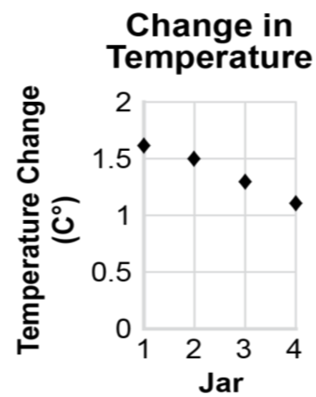
Write one or two sentences. It is **not** important for your prediction to be correct. You will explain whether or not your prediction is supported later.

{response space is provided in student version}

Data from the student's experiment are shown in the table and graph below. Think about the prediction you made as you look over these data.

Volume and Temperature Data

	Jar 1	Jar 2	Jar 3	Jar 4
Volume (mL)	100	125	150	175
Starting Temp. (°C)	22.3	22.3	22.3	22.3
Ending Temp. (°C)	23.9	23.8	23.6	23.4
Temp Change (°C)	1.6	1.5	1.3	1.1



Item: 2	**Item Format: CR**
Grade: 8	
PE/PE Bundle: MS-PS3-4	**Total Points:** 2
Dimensions: SEP: ARG **DCI:** PS3.A; PS3.B	**Key(s):** See Scoring below.
Focus: How does mass affect temperature change?	

Question 2.

Part A
Does the data in the graph support the prediction you made in Question 1?

Circle one:	**Yes**	**No**

Part B
Explain how the data support or do not support your prediction. Use data from the graph and/or table to support your explanation.

{response space is provided in student version}

Scoring for Question 2:
Two points total:

- One point for indicating whether the graph shows evidence of the direction of heat transfer in the prediction.
- One point for indicating whether the graph shows the change in temperature described in the prediction.

Note for Scoring: no credit is given for the answer to Part A.

Sample Student Response: *The response should include an explanation for the comparison, using the data in the graph as evidence.*
The table and graph both show that the water in each jar increased in temperature. This is evidence that heat transferred from the hot pack to the water in the jar, which supports my prediction. The graph and table also shows that the temperature change is greater in jars with less water (smaller volume), so this part of my prediction is not supported by evidence.

Hot Pack Investigation #2

The student collects the data shown in the table before and after using an instant hot pack on his arm.

Instant Hot Pack Data

	Before Using	After Using
Mass of Instant Hot Pack	300 g	300 g
Temperature of Instant Hot Pack	45°C	15°C
Temperature of Arm	30°C	35°C
Temperature of Room	20°C	20°C

Item: 3	**Item Format: MS**
Grade: 8	
PE/PE Bundle: MS-PS3-4	**Total Points:** 1
Dimensions: SEP: ARG **DCI:** PS3.A, PS3.B **CCC:** E/M	**Key(s):** A, D
Focus: Conservation of mass and energy	
Phenomenon (if applicable): A hot pack warms the skin, but the hot pack cools. This is evidence that energy is conserved, because energy is transferred, not created or destroyed. The mass of the hot pack does not change.	

Question 3. Which statements support the student's claim that the matter and energy of the instant hot pack are conserved even though the temperature of the instant hot pack changed?

Select the **two** correct statements.

A. The mass of the instant hot pack did not change because the same amount of matter was present.*

B. The mass of the instant hot pack did not change because the total amount of energy was conserved.

C. Matter was conserved because it flowed from the hot pack to the arm, as shown by the temperature data.

D. Energy was conserved because it flowed from the instant hot pack into the arm causing the arm to warm, as shown by the temperature data.*

E. The instant hot pack transferred energy as cold flowed from the arm into the hot pack and changed the temperature of the arm, until both were at the same temperature.

Hot Pack Investigation #3

The student wants to test how the ratio between the mass of a hot pack and the mass of a water sample relates to temperature change. The student designs the procedure shown below.

Student's Procedure

1. Place a beaker with 50 mL of room-temperature water on top of a 300-g hot pack.
2. Place a beaker with 100 mL of room-temperature water on top of a 600-g hot pack.

The student realizes he must redesign his procedure before conducting the test.

Item: 4	**Item Format: CR**
Grade: 8	
PE/PE Bundle: MS-PS3-4	**Total Points:** 2
Dimensions: SEP: INV **DCI:** PS3.A, PS3.B **CCC:** SPQ	**Key(s):** See Scoring below
Focus: How can you design a better hot pack?	

Question 4. Explain how the student should redesign the procedure to test how the ratio between the mass of a hot pack and the mass of a water sample relates to temperature change. Use what you know about proportion and quantity to support your explanation.

{response space is provided in student version}

Scoring for Item 4:
Two points total:

- One point for explanation of how the student should redesign the procedure.
- One point for correct use of proportion and quantity to support the explanation.

Sample Student Response: The student could revise his procedure so that either the volume of the water or mass of the hot pack are increased, but not both. Increasing the sizes of both the hot pack and the water proportionally causes the ratio of salt to water to remain constant. In order to test the ratio, the increase cannot be proportional. The student must increase the quantity of either the mass of the water or the mass of the hot pack while keeping the other quantity the same.

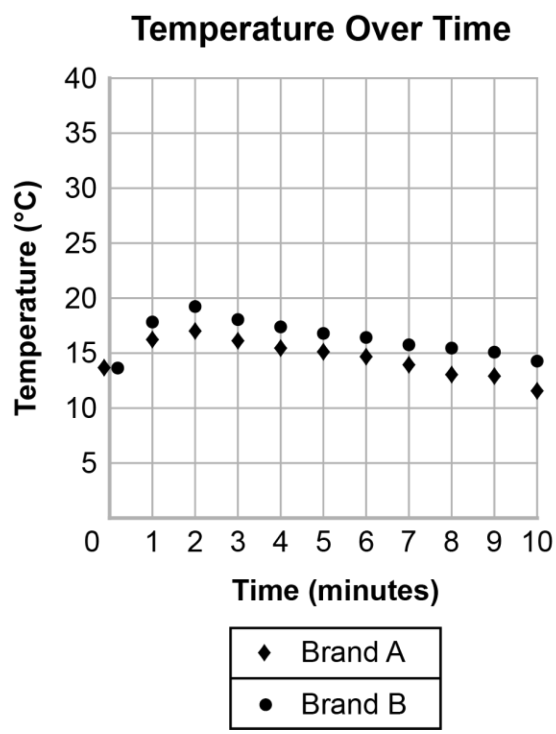
Hot Pack Investigation #4

The student notices that the ratio of salt to water is different in different brands of hot packs. The student tests two different brands of hot packs to see how this ratio affects the temperature of the hot pack over time. The student places two different hot packs on two identical metal benches outside on a cool day and records the temperature of each hot pack each minute for ten minutes.

The student's data are shown below.

Hot Pack Brands Data

Hot Pack Brand	Mass of Salt (in g)	Volume of Water (in mL)
A	75.0	300
B	100.0	300



Item: 5	**Item Format: MC/MS**
Grade: 8	
PE/PE Bundle: MS-PS3-4	**Total Points:** 2
Dimensions: DCI: PS3.A, PS3.B **CCC:** SPQ	**Key(s): Part A:** C **Part B:** B, E
Focus: How does the ratio of salt to water relate to how well a hot pack works?	

Question 5.

Part A
Which claim is **best** supported by the students' data?

A. A salt solution with more mass will have a higher temperature than a salt solution with less mass.
B. A salt solution with more water than salt will have a higher temperature than a salt solution with more salt than water.
C. A salt solution with a higher ratio of salt to water will have a higher temperature than a salt solution with a lower ratio of salt to water.*
D. A salt solution with a greater total volume of salt and water will have a higher temperature than a salt solution with a smaller total volume of salt and water.

Part B
Based on the data, which combinations of salt and water will likely reach a higher temperature than either Brand A or Brand B?

Select the **two** correct answers.

A. 75.0 g of salt and 250 mL of water
B. 100.0 g of salt and 250 mL of water*
C. 100.0 g of salt and 400 mL of water
D. 125.0 g of salt and 400 mL of water
E. 150.0 g of salt and 400 mL of water*

Item: 6	**Item Format: Model drawing, CR**
Grade: 8	
PE/PE Bundle: MS-PS3-5	**Total Points:** 3 (Part A: 2 points; Part B: 1 point)
Dimensions: SEP: ARG **DCI:** PS3.A, PS3.B **CCC:** E/M	**Key(s):** See Scoring below
Focus: Why do hot packs feel hot?	

Question 6. The student looks at the hot packs on the bench and determines the hot packs and the bench can be thought of as two interacting systems. The student wants to model energy flow and average kinetic energy of the particles at different locations as these two systems interact.

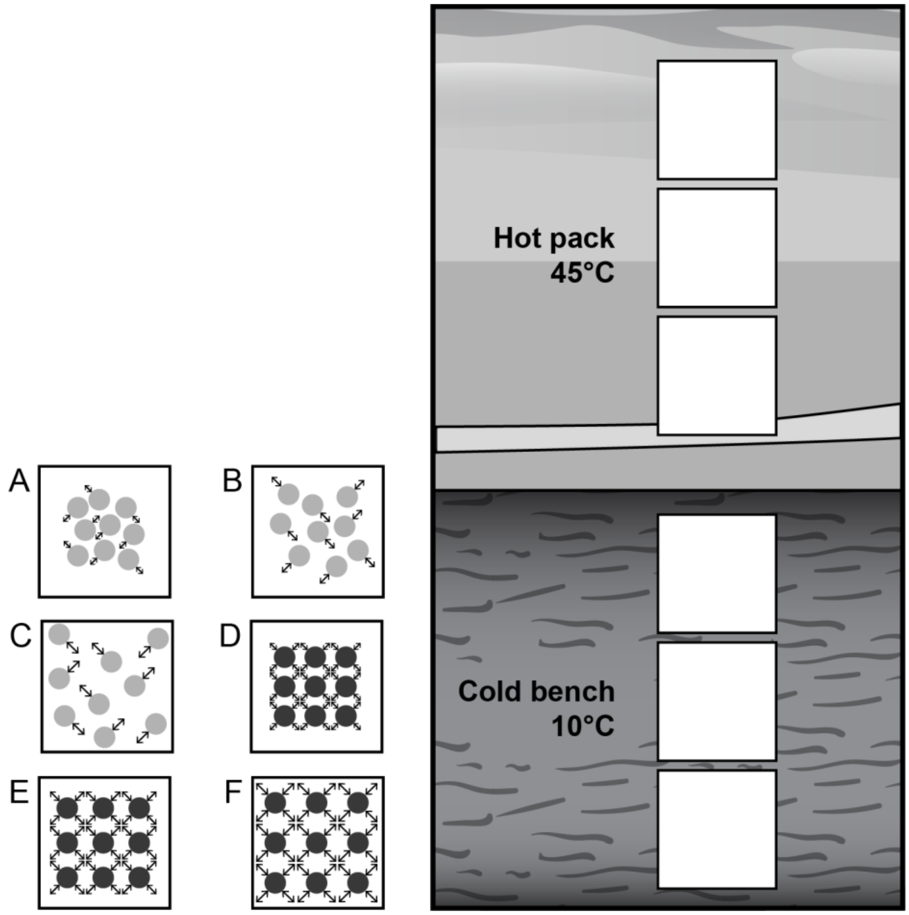
Part A

Follow these steps to complete the students' model:

Step 1: Look at the six particle pictures, labeled A-F, below. Each picture represents the motion of the particles at one location in the model.

Step 2: Write the letter of the picture (A-F) that **best** represents the motion of the particles in each white box on the model. Each letter should only be used **one** time.

Step 3: On the model, draw **one** large arrow to show the direction in which energy is transferred between the hot pack and the cold bench in this system.



Part B
Explain how the kinetic energy of the molecules in the instant hot pack and in the cold bench will change as a result of the heat transfer you modeled in Part A.

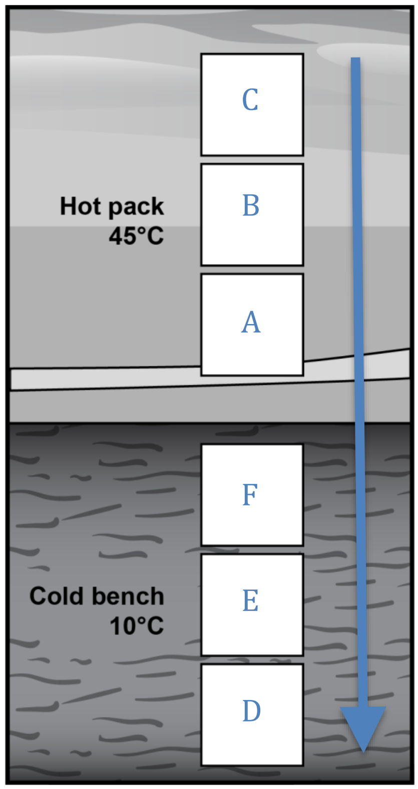
{response space is provided in student version}

Scoring for Item 6:
(3 points total)

Part A

Two points:

- One point for correct order of letters
- One point for correct direction of large arrow



Part B

One point:

- One point for explanation of energy transfer among the two systems

Sample Student Response: Energy transfers from the hot pack to the bench because the hot pack is warmer than the cold bench. This causes the kinetic energy of the particles in the hot pack to decrease and the kinetic energy of the particles in the cold bench to increase.