

Phase Changes

Grade-Level Expectations

The exercises in these instructional tasks address content related to the following science grade-level expectations:

SI-M-A4 Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI GLE 11)

PS-M-A4 Draw or model the movement of atoms in solid, liquid, and gaseous states (PS GLE 6)

PS-M-A5 Determine the temperatures at which water changes physical phases (e.g., freezing point, melting point, boiling point) (PS GLE 8)

Contents

- These instructional tasks contain a set of document- or resource-based exercises about *phase changes in matter*.
- Teachers may choose to use or modify the tasks as part of an instructional lesson or as a formative or summative assessment.
- The printable student version excludes teacher directions.

| | Objective(s) |
|--|--|
| <u>Scaffolding Exercise 1</u> | <ul style="list-style-type: none"> • Model the position and motion of a substance in different phases • Describe the motion of particles in different phases |
| <u>Scaffolding Exercise 2</u> | <ul style="list-style-type: none"> • Apply knowledge of particle movement in solids to real-world situations |
| <u>Scaffolding Exercise 3</u> | <ul style="list-style-type: none"> • Describe phase changes in a scenario • Write a scientific explanation using appropriate vocabulary |
| <u>Culminating Exercise</u> | <ul style="list-style-type: none"> • Interpret a graph • Identify and describe processes occurring during phase changes |
| <u>Scoring Rubric</u> | |
| <u>Scoring Notes</u> | |
| <u>Printable Student Version</u> | |

Teacher Directions

Have students read the text and complete the chart. You may also want students to access outside resources to strengthen their understanding.

Phases of Matter

Matter occurs in different states or phases including solids, liquids, gases, and plasma. The behavior of the particles of matter differs in each of the phases. The particles in matter are affected when heat, also called thermal energy, is gained or lost.

A change in the phase of matter can occur if enough energy is added or lost. During the actual phase change, the temperature does not change; however, intermolecular forces are impacted by the energy transfer. During energy transfer, the particles of matter either move faster and farther apart or move slower and closer together until the phase change is accomplished.

| Task | Solid | Liquid | Gas |
|--|-------|--------|-----|
| Draw a model of particle positions and motion in each phase of matter in the boxes provided. Include nine particles in each model. | | | |
| Describe the motion of the particles in each phase. | | | |

Scaffolding Exercise 2

Teacher Directions: Have students examine the scenario below to respond the prompts that follow.



When engineers design roads and bridges, they include expansion joints at key locations. These joints are necessary for the structures to remain stable over time.

- A. Using your knowledge of matter and the effects of thermal energy, describe why expansion joints are necessary in large structures.

B. Structures built in locations with relatively constant temperatures are designed differently than those built in locations with high differences of temperatures. Explain why this difference is necessary and how climate affects the engineering of large structures.

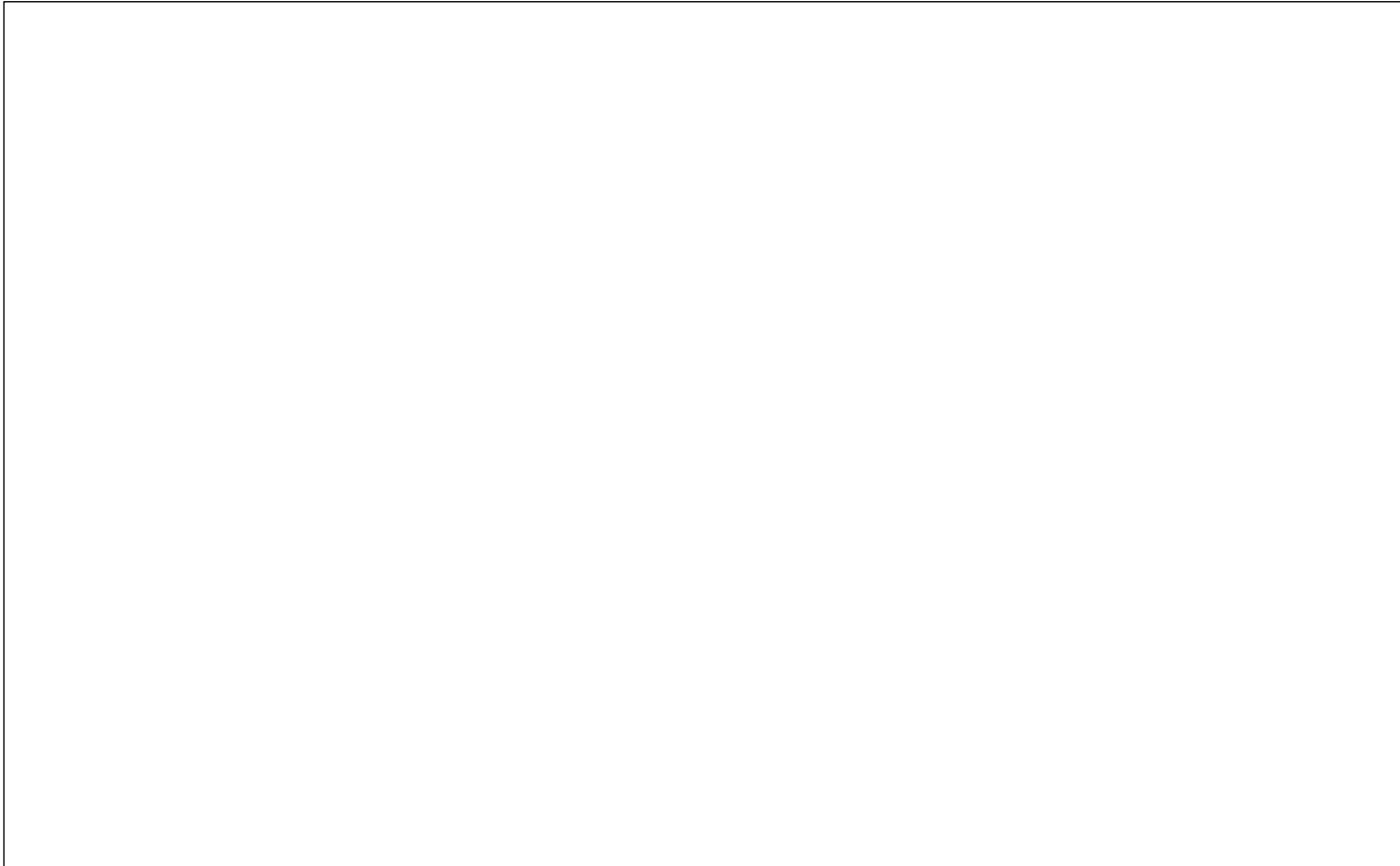
Teacher Directions:

Have students read the scenario found at http://staff.concord.org/~btinker/workbench_web/states_of_matter/control_nature.html and discuss the questions with a partner. Then, have students respond to the prompt below.

Student Directions:

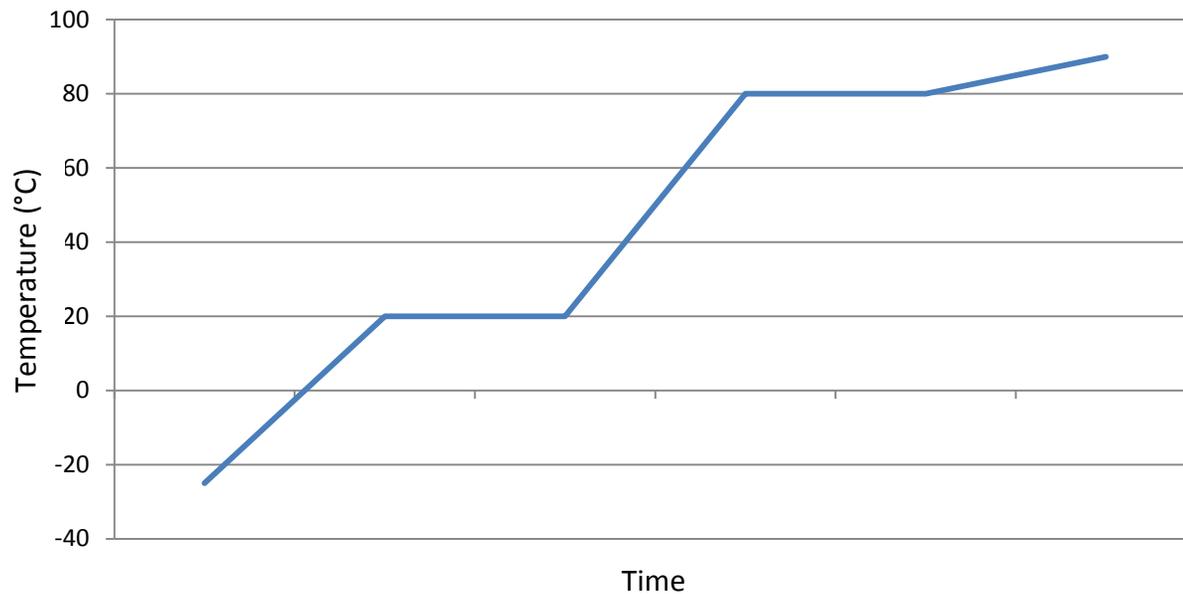
After reading the scenario found at http://staff.concord.org/~btinker/workbench_web/states_of_matter/control_nature.html and discussing the questions with a partner, write a scientific explanation of the matter changes presented in the scenario. Include the following words in your explanation: thermal, particles, transfer, energy, solid, liquid, gas.

Write Your Scientific Explanation in the Box Below



Culminating Exercise

Teacher Directions: Have students analyze the graph to respond to the prompts that follow.



- What is the melting point of the substance? Explain your reasoning.
- What is the boiling point of the substance? Explain your reasoning.
- What state of matter is the substance in at 40°C? Explain your reasoning.
- Determine if this substance is water and provide evidence to support your answer.

Rubric

Key Elements:

- A.** The response correctly determines the melting point of the substance and explains the reasoning.
- B.** The response correctly determines the boiling point of the substance and explains the reasoning.
- C.** The response correctly identifies the state of matter of the substance and explains the reasoning.
- D.** The response correctly determines if the substance is/is not water and provides evidence to support the answer.

4 Points

Response includes all four key elements.
Response contains no scientific errors.

3 Points

Response includes three of the four key elements.
Response may include scientific errors.

2 Points

Response includes two of the four key elements.
Response may include scientific errors.

1 Point

Response includes one of the four key elements.
Response may include scientific errors.

A well-developed response should demonstrate a correct and thorough understanding of phase changes. The response should be clear, include specific details, show a higher level of reasoning skills where appropriate, and address the key elements of the task.

Scoring Notes

Student responses will not be an exact imitation of the responses below. These are given only as examples.

A. According to the graph, the substance starts at a temperature below freezing. The graph shows an increase in temperature until 20°C . Once the substance reaches that temperature, it changes from a solid to a liquid. This is the melting point of the substance. A phase change is apparent when the temperature does not increase over a period of time although energy is being added.

B. Once the substance changed from the solid to liquid phase at 20°C , the next phase change should be from liquid to gas. The graph shows an increase in temperature until 80°C . Once the substance reaches that temperature, it changes from a liquid to a gas. This is the boiling point of the substance. Again, by looking at the graph there is not an increase in temperature over a period of time which indicates a phase change.

C. The substance is a liquid at 40°C . The substance underwent a phase change at 20°C where it went from the solid to liquid phase. The substance remains a liquid from 40°C to 80°C .

D. The substance is not water. Water has a melting point of 0°C and a boiling point of 100°C . Since the unknown substance has a different melting and boiling point as evidenced on the graph, it cannot be water.

**Printable
Student Version**

Read the text and complete the chart. You may also want to access outside resources to strengthen their understanding.

Phases of Matter

Matter occurs in different states or phases including solids, liquids, gases, and plasma. The behavior of the particles of matter differs in each of the phases. The particles in matter are affected when heat, also called thermal energy, is gained or lost.

A change in the phase of matter can occur if enough energy is added or lost. During the actual phase change, the temperature does not change; however, intermolecular forces are impacted by the energy transfer. During energy transfer, the particles of matter either move faster and farther apart or move slower and closer together until the phase change is accomplished.

| Task | Solid | Liquid | Gas |
|---|-------|--------|-----|
| Draw a model of particle positions and motion in each phase of matter in the boxes provided. Include nine particles in each model. | | | |
| Describe the motion of the particles in each phase. | | | |

Examine the scenario below to respond the prompts that follow.



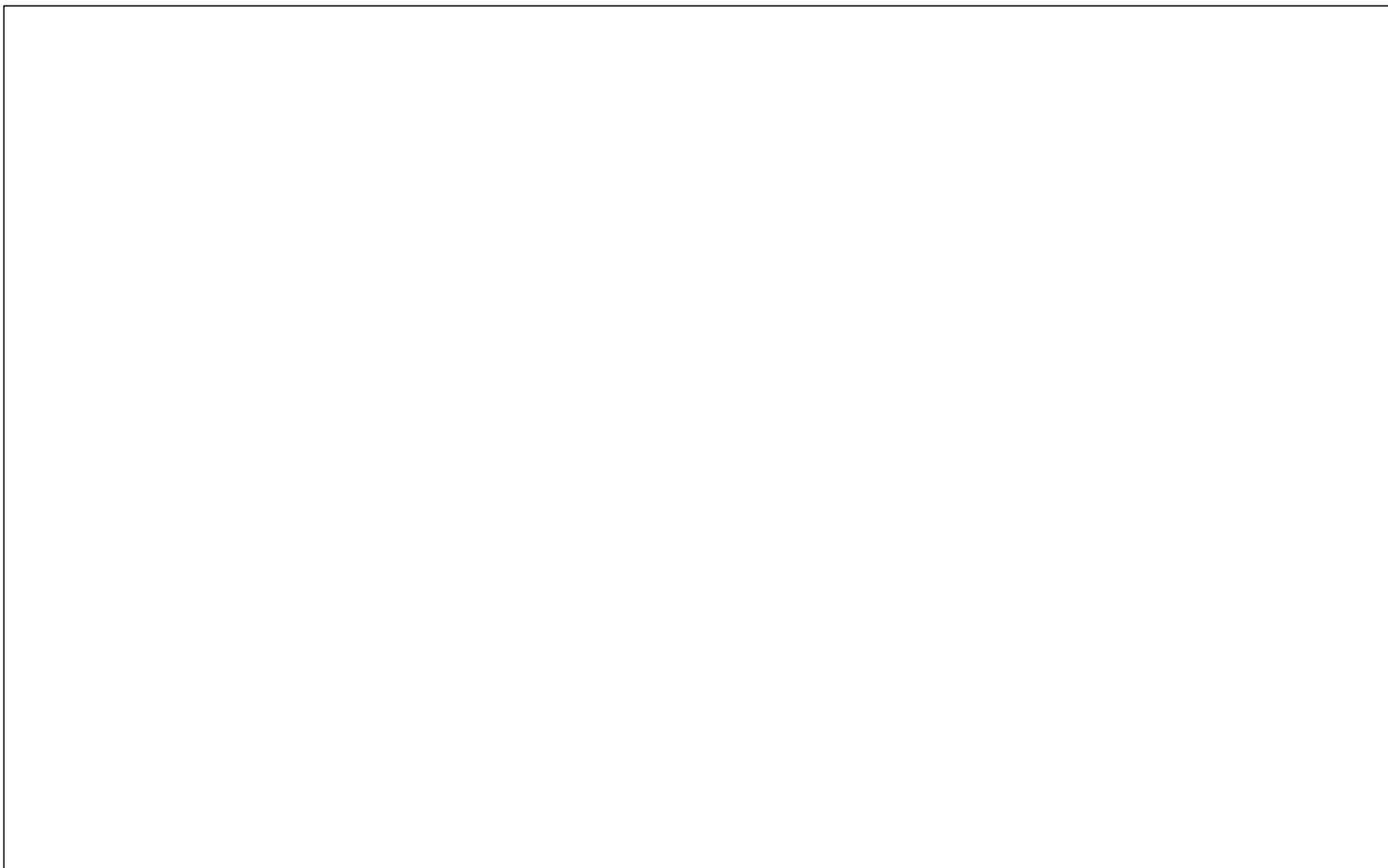
When engineers design roads and bridges, they include expansion joints at key locations. These joints are necessary for the structures to remain stable over time.

- B. Using your knowledge of matter and the effects of thermal energy, describe why expansion joints are necessary in large structures.

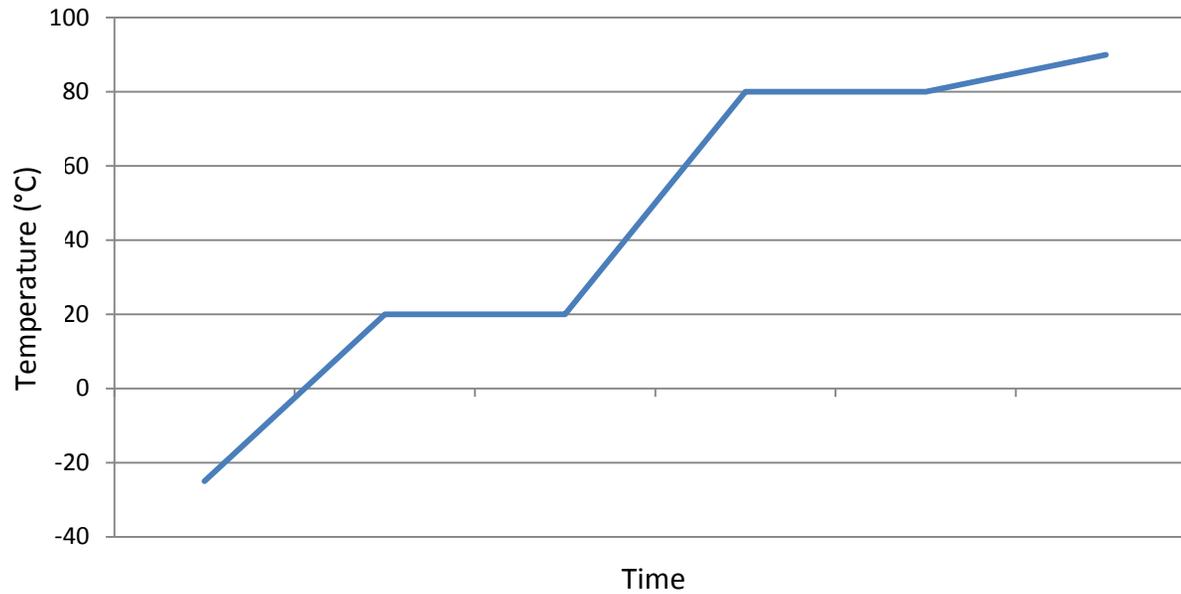
B. Structures built in locations with relatively constant temperatures are designed differently than those built in locations with high differences of temperatures. Explain why this difference is necessary and how climate affects the engineering of large structures.

After reading the scenario found at http://staff.concord.org/~btinker/workbench_web/states_of_matter/control_nature.html and discussing the questions with a partner, write a scientific explanation of the matter changes presented in the scenario. Include the following words in your explanation: thermal, particles, transfer, energy, solid, liquid, gas.

Write Your Scientific Explanation in the Box Below

A large, empty rectangular box with a thin black border, intended for the student to write their scientific explanation. The box is currently blank.

Analyze the graph to respond to the prompts that follow.



- What is the melting point of the substance? Explain your reasoning.
- What is the boiling point of the substance? Explain your reasoning.
- What state of matter is the substance in at 40°C? Explain your reasoning.
- Determine if this substance is water and provide evidence to support your answer.