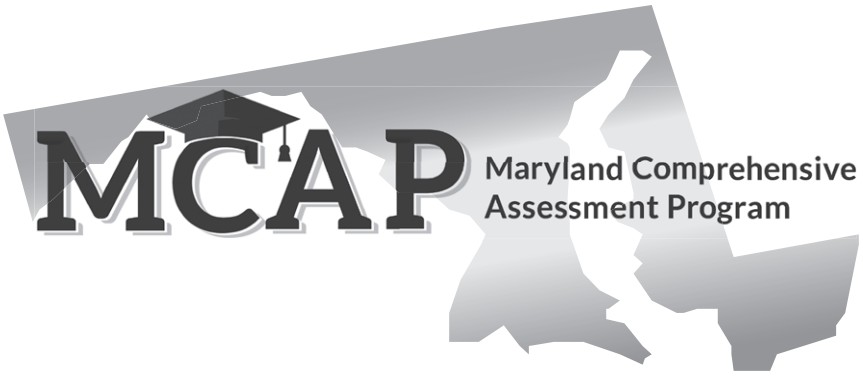


MISA

Maryland Integrated Science Assessment

2019 Sample Items

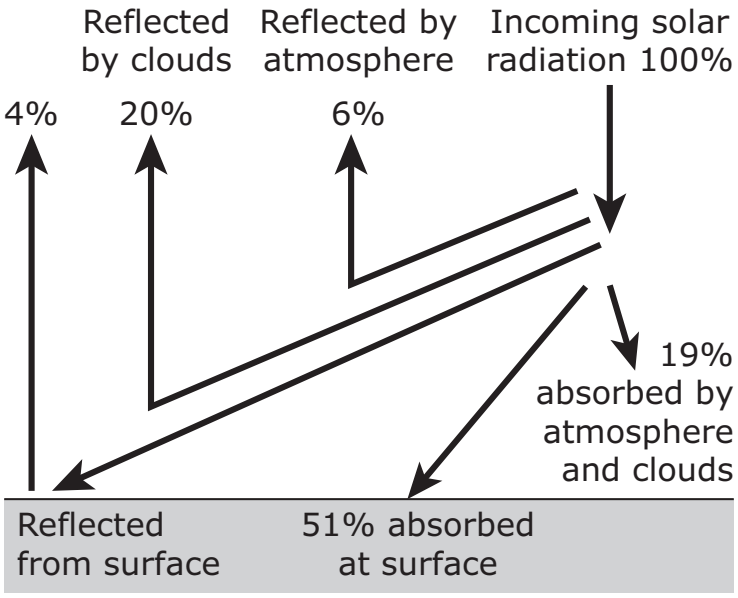
Developed and published under contract with the Maryland State Department of Education by Cognia.

Read the information. Use the information to answer the questions.

Earth's Energy Flow

Electromagnetic radiation from the Sun makes Earth's climate livable for a wide range of organisms. The model shows solar radiation entering Earth's atmosphere. The radiation can be scattered, reflected, or absorbed by clouds and particles in the atmosphere. Surface land and water can absorb or reflect solar radiation that passes through the atmosphere. The model shows the overall flow of energy between the Sun, Earth, and Earth's atmosphere over a four-year period.

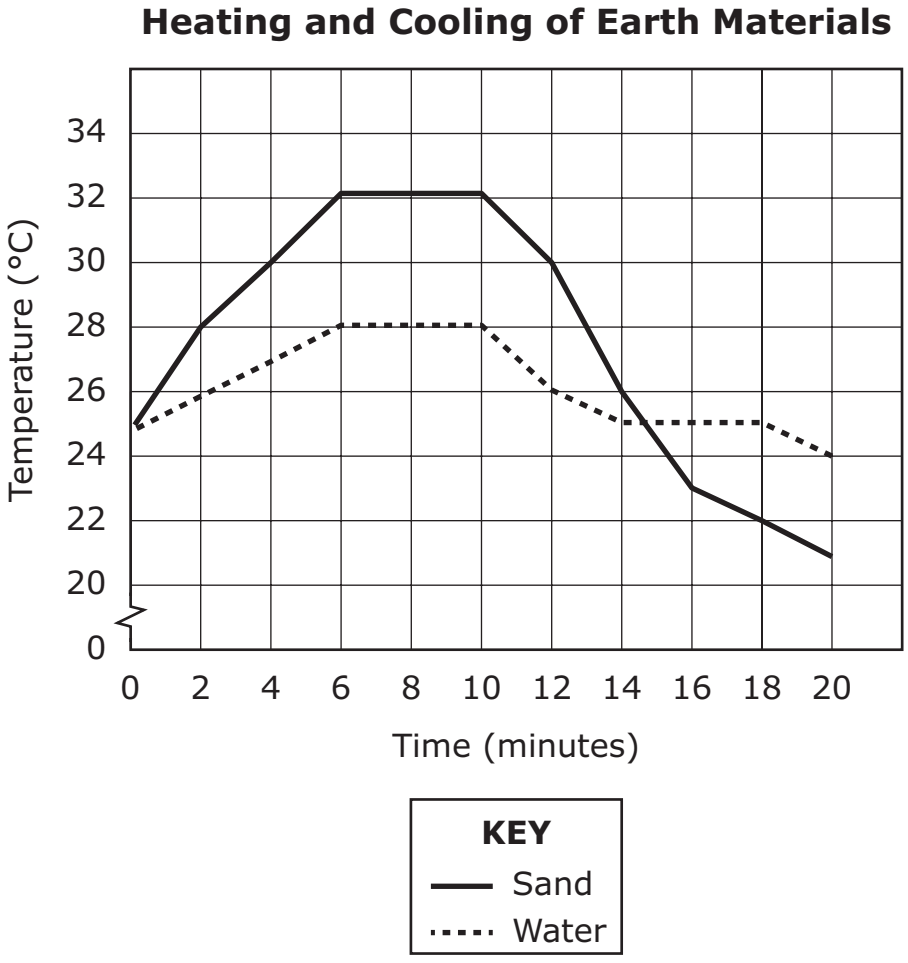
Earth's Energy Flow



Specific Heat Experiment

A group of students want to examine how the storage of solar radiation impacts Earth's global climate. They decide to perform an experiment in which they determine how land and water absorb and retain thermal energy. To represent land, the students use sand.

The students place each material in a beaker and place them under a heat lamp for 10 minutes. Every 2 minutes they record the temperatures. After 10 minutes, the students turn off the heat lamp and continue to record the temperatures as the materials cool. The students created the graph using the data they collected.



Specific heat is a measure of the amount of heat needed to raise the temperature of one gram of a substance by one degree Celsius. The group of students perform the following experiment.

GO ON

The students determine the specific heat of the two materials tested using their data gathered during the experiment. The students compare their results to the values of other materials shown in the table.

Specific Heat of Earth Materials

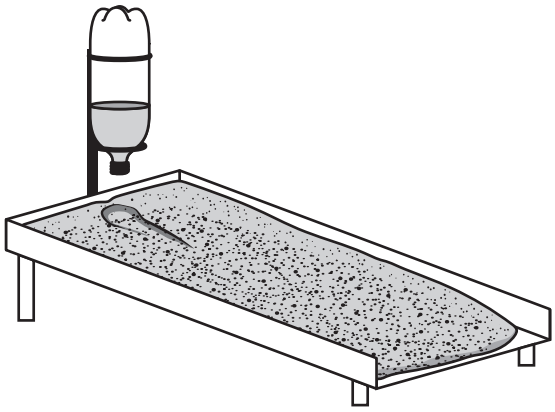
Material	Specific Heat (Joule/gram °C)
Liquid water	4.18
Solid water (ice)	2.11
Water vapor	2.00
Seawater	3.90
Oxygen (gas)	0.92
Dry air	1.01
Moist air	1.44
Granite rock	0.84
Dry sand	0.80
Moist sand	2.51

Stream Table Experiment

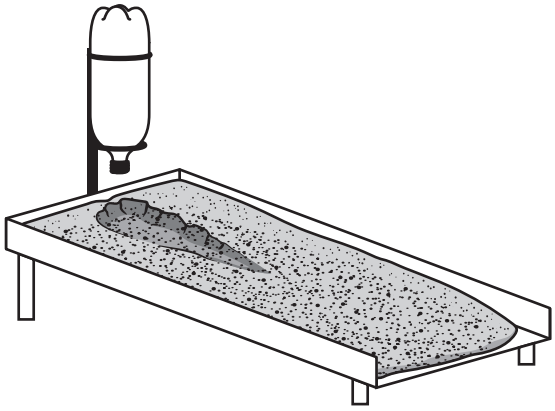
Changes to Earth's solar radiation input, output, storage, and distribution affect all of Earth's systems. One phenomenon in particular is the increase of evaporation and precipitation.

The students conducted an experiment to see how land surfaces were impacted by an increase in precipitation. They used a stream table to observe the movement and deposition of eroded land surfaces. Each bottle was filled with 1000 milliliters of water before the students began the experiment. In the first trial the students gently released 500 milliliters of water over a bed of soil creating a small divot. During trial 2 the students gently released 1000 milliliters of water over a bed of soil creating a deeper divot. The difference in soil erosion is shown.

Trial 1



Trial 2



1 Based on the Earth's Energy Flow model, which statement **best** describes how a greater than normal amount of clouds in the air would affect the distribution of energy in the ocean?

A More solar radiation would penetrate deep ocean water with no effect on energy storage.

B More solar radiation would penetrate deep ocean water, trapping more energy.

C Less solar radiation would penetrate the ocean's surface, reducing the storage of energy.

D Less solar radiation would penetrate the ocean's surface with no effect on energy storage.

2 Which phenomenon are the students **most likely** trying to understand by investigating the specific heat of several earth materials?

A the amount of thermal energy each Earth material is able to reflect and redistribute

B the amount of thermal energy each Earth material is able to store and redistribute

C the time it takes for different Earth materials to heat up as well as the time it takes for their stored energy to go away

D the time it takes for the air around each Earth material to be heated or cooled

3 Use the data from the Specific Heat of Earth Materials table to select the words to compare the absorption of heat in different forms of water.

Water vapor absorbs incoming solar radiation at {a higher rate than/a lower rate than/the same rate as} liquid water. Seawater absorbs incoming solar radiation at {a higher rate than/a lower rate than/the same rate as} liquid water. The form of water that will hold the most energy is {liquid water/ice/seawater}.

4 Which change to the specific heat experiment might the students have made to better understand the relationship between specific heat of earth materials and climate?

A Set up a thermometer in each beaker to record the temperature of the air inside the beakers.

B Heat the materials for a longer period of time until they could not have absorbed any more thermal energy.

C Test salt water and rock as well to compare the results with other earth materials.

D Record temperature data until the earth material stopped cooling off.

5 Use the information in the stream table experiment to answer the questions.

Part A

Which statement describes how the stream table experiment can be improved to better represent the processes of Earth's surface?

A Add a heat source above the stream table to simulate the Sun.

B Add different types of soil, rocks, and vegetation to the table.

C Release the water all at once to better simulate rainfall.

D Increase the slope of the table to better represent the natural landscape.

Part B

Which measurement could the students use in their stream table experiment?

A the time it takes for the water to run off the table

B the time it takes for soil erosion to occur

C the amount of moisture stored in the soil

D the amount of soil that was deposited in a new location

6 Use evidence and the model provided to identify and describe a cause-and-effect relationship between energy flow and earth materials in various earth systems.

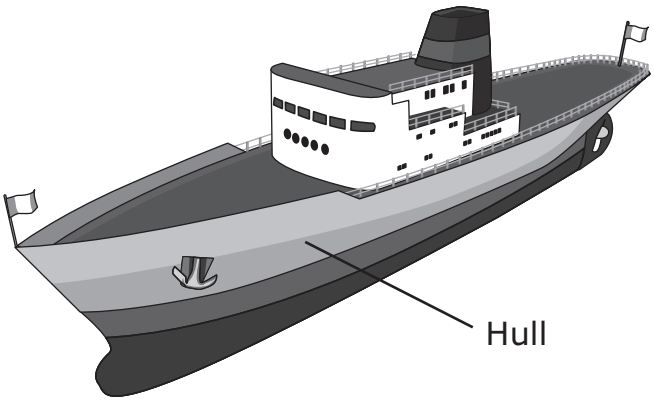
Write your answer on the lines on your Answer Sheet.

Read the information. Use the information to answer the questions.

Preventing the Corrosion of Ship Hulls

Zinc is a metal used to protect iron ship hulls from rust and corrosion as they sail in the ocean. In recent years, oceans all over the world have shown an increase in acidity levels. Scientists have been testing how zinc reacts to acids to see how long the protective barrier on a ship's hull will last under the increased acidic conditions. If the iron hull of a ship is damaged it could cost up to hundreds of thousands of dollars to repair.

Ship Hull

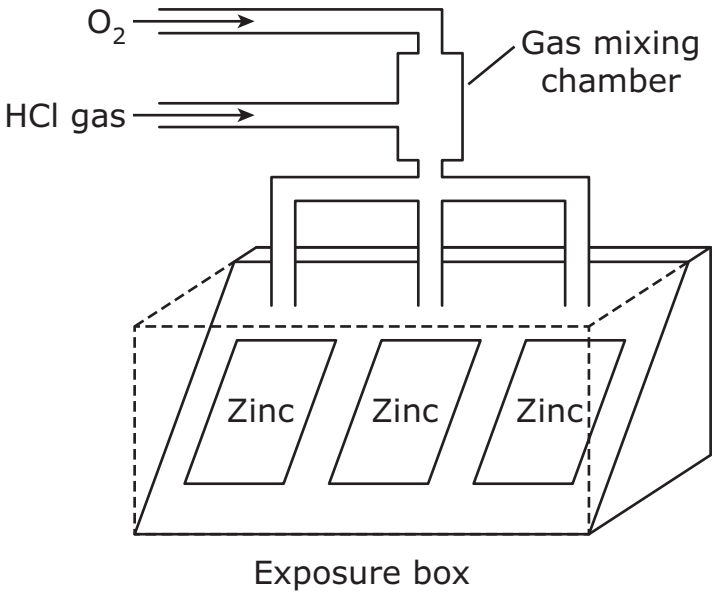


Lab experiments have focused on the reaction between zinc (Zn) and hydrochloric acid (HCl) in low concentrations. The reaction between zinc and hydrochloric acid and a diagram of an iron ship hull are shown.

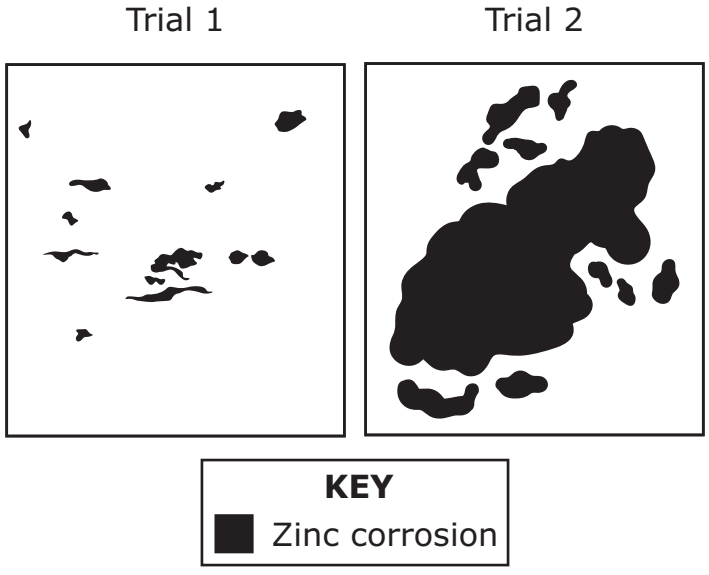
$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

In one experiment, scientists placed three pieces of zinc into an exposure box with air flowing over the zinc. The air used is a combination of oxygen (O_2) and HCl gas that is diluted to the desired molar concentration. In the first trial the zinc was exposed to HCl at a rate of 2.5 x 10^{-6} milligrams of HCl per square centimeter of zinc per second (mg/cm^2/s). In the second trial the zinc was exposed to HCl at a rate of 8.3 x 10^{-6} mg/cm^2/s. The experimental set up and results from the two trials are shown.

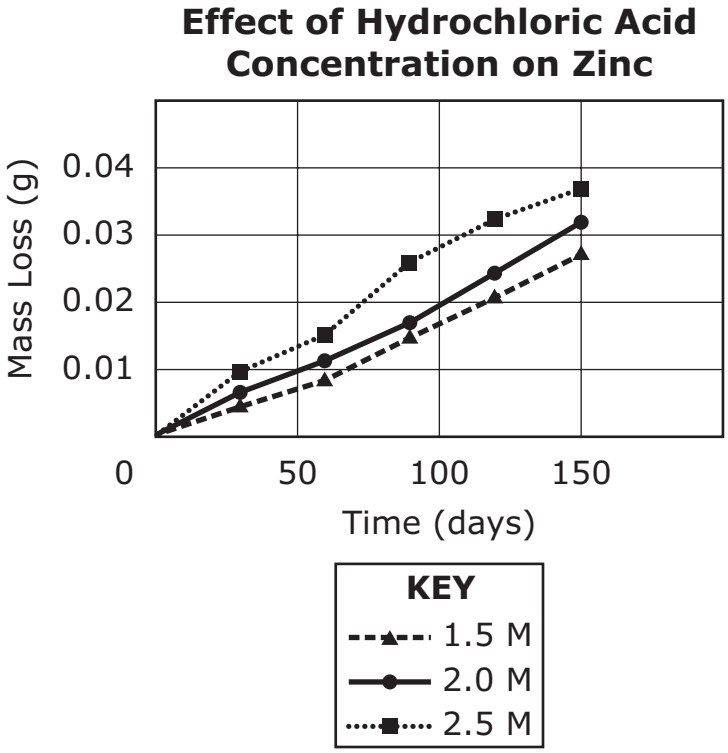
Experimental Set-up



Experimental Results

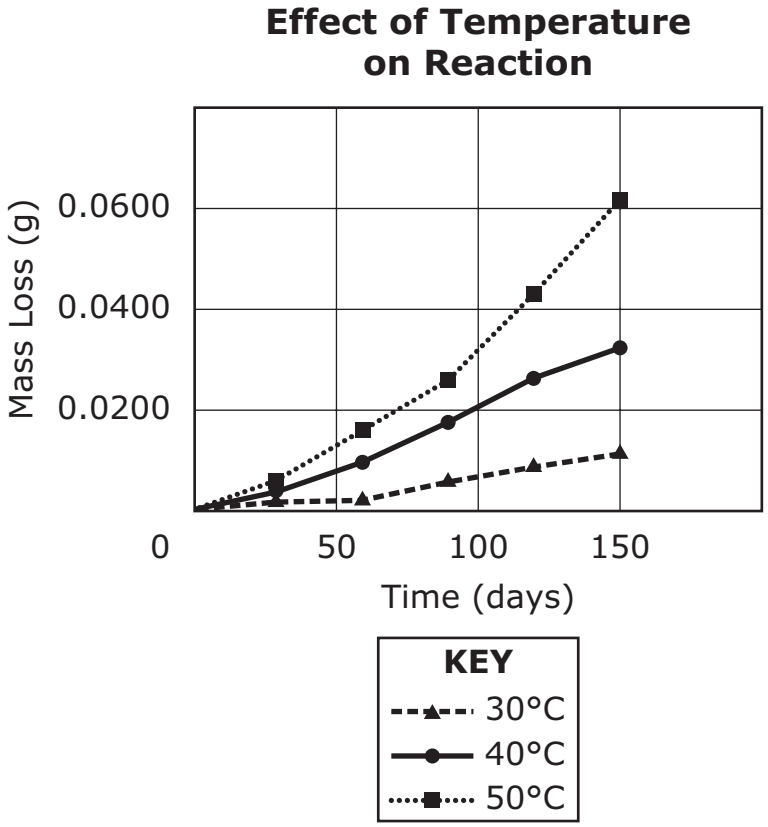


In another experiment, scientists placed individual pieces of zinc into three different beakers. They filled the beakers with 1.5 molar (M), 2.0M, and 2.5M HCl respectively. Over the course of 150 days the scientists measured how many grams of zinc were lost each day in each beaker. The graph shows data collected during the experiment.



Effect of Temperature

Next, the scientists tested how temperature affects the rate of the reaction of zinc and hydrochloric acid. The scientists placed individual pieces of zinc in three different beakers filled with 2.0M HCl. They heated the beakers to 30°C, 40°C, and 50°C respectively and held them at those temperatures for 150 days. During the experiment, the scientists once again measured the mass of zinc lost over time. The graph shows the results.



7 Which sequence of events **best** describes the pattern shown in the Effect of Hydrochloric Acid Concentration on Zinc graph?

A concentration increases → distance between ions decreases → particle collisions and rate of reaction increase

B concentration increases → distance between ions increases → particle collisions and rate of reaction increase

C concentration decreases → distance between ions decreases → particle collisions and rate of reaction increase

D concentration decreases → distance between ions increases → particle collisions and rate of reaction increase

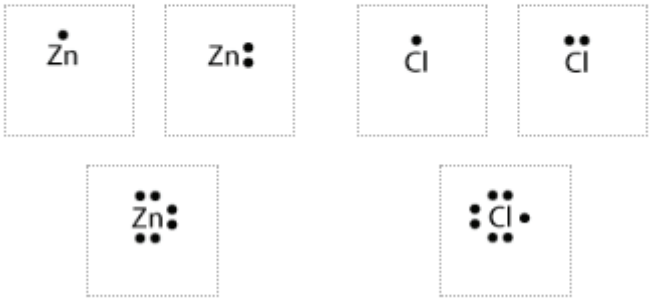
8 Use the Periodic Table of the Elements to select the phrases that **best** describe the reactivity patterns between chlorine and zinc.

When compared with zinc, chlorine has a {lower/higher/similar} electronegativity. Atoms of {chlorine/zinc} are highly electronegative and they want to {gain electrons from/donate electrons to} atoms of other elements.

When zinc and chlorine react to form zinc chloride, atoms of both elements end up with {full inner/full outer/partially filled inner/partially filled outer} electron shells, which makes them {more/less} stable.

9 Use the Periodic Table of the Elements to answer the questions.

Part A
Select the two models that correctly show the valence electron configurations for zinc and chlorine.



Part B
Which element could replace zinc in this reaction because it would react in the same way with HCl?

(A) barium because it is in group 2

(B) nitrogen because it is a nonmetal

(C) carbon because it is in group 14

(D) bromine because it is in the same period as zinc

GO ON

10 Which statement **best** describes how the temperature of hydrochloric acid affects the energy of its molecules and frequency of collisions?

A As temperatures increase, the energy of the molecules and frequency of collisions increase.

B As temperatures decrease, the energy of the molecules and frequency of collisions increase.

C As temperatures increase, the energy of the molecules increases and frequency of collisions decreases.

D As temperatures decrease, the energy of the molecules decreases and frequency of collisions increases.

11 Which statement **best** describes what happens to form the products of the reaction between HCl and Zn?

A Molecules of the reactants collide, breaking their bonds and forming new bonds, creating the products.

B Molecules with low kinetic energy break their bonds and form new bonds, creating the products.

C Molecules of the reactants form covalent bonds by sharing valence electrons with each other and form new products.

D Molecules of the reactants form ionic bonds by sharing valence electrons with each other and form new products.

12 A group of students wanted to know how batteries are able to produce energy.

The students began studying the reaction that occurs in zinc-bromide batteries. They want to know how the reaction between Zinc (Zn) and Hydrobromic Acid (HBr) occurs to produce the batteries' energy.

Using the Periodic Table of the Elements, construct a balanced chemical equation using Zn and HBr as the reactants. Explain how you were able to determine how the compounds would react with each other based on the patterns of the Periodic Table of the Elements.

Write your answer on the lines on your Answer Sheet.

2021 Sample Items ANSWER KEY
MISA

Item Number	Key	Evidence Statements
1	C	**HS-ESS2-4/1.a.iv:** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
2	C	**HS-ESS2-5/1.a:** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
3	TEI*	**HS-ESS2-5/2.a.ii:** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
4	B	**HS-ESS2-5/5.b:** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
5	B; D	**HS-ESS2-5/3.a.ii:** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
6	CR-3	**HS-ESS2-4/3.a.i:** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
7	B	**HS-PS1-5/2.a.i:** Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
8	TEI*	**HS-PS1-2/2.a.v:** Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
9	TEI*	**HS-PS1-2/1.a.iii:** Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
10	A	**HS-PS1-5/3.a.iii:** Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
11	A	**HS-PS1-5/3.a.i:** Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
12	CR-2	**HS-PS1-2/4.a:** Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

☐ = Written response.

* Technology Enhanced Item – Correct responses shown on the following pages.

Item 3. TEI correct response:

Use the data from the Specific Heat of Earth Materials table to select the words to compare the absorption of heat in different forms of water.

Water vapor absorbs incoming solar radiation at [a higher rate than] liquid water. Seawater absorbs incoming solar radiation at [a higher rate than] liquid water. The form of water that will hold the most energy is [liquid water].

Item 8. TEI correct response:

Use the Periodic Table of the Elements to select the phrases that **best** describe the reactivity patterns between chlorine and zinc.

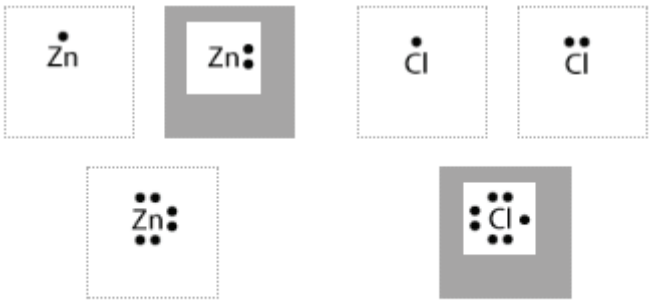
When compared with zinc, chlorine has a [higher] electronegativity. Atoms of [chlorine] are highly electronegative and they want to [gain electrons from] atoms of other elements.

When zinc and chlorine react to form zinc chloride, atoms of both elements end up with [full outer] electron shells, which makes them [more] stable.

Item 9. TEI correct response:

Use the Periodic Table of the Elements to answer the questions.

Part A
Select the two models that correctly show the valence electron configurations for zinc and chlorine.



Part B
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