EOT1

Science

Grade 6 General

2023-2024

الأسئلة الموضوعية MCQ

MCQ - الأسئلة الموضوعية

6	Explain how the particle movment and collision allow the spread of matter in terms of diffusion	Textbook, figures, investigation	12, 13, 14
7	Define thermal expansion and thermal contraction and compare between them according to: energy change, tempreature, particle movment, volume, ... Etc.	textbook, figures, 3D	17, 18, 19
8	Plan an investigation to determine the relationships among the energy transferred in solids, the **mass**, the volume, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.	textbook, investigations, 3D	20, 24
9	Diffrentiate between evaporation and bioling point	textbook, figure, table	40
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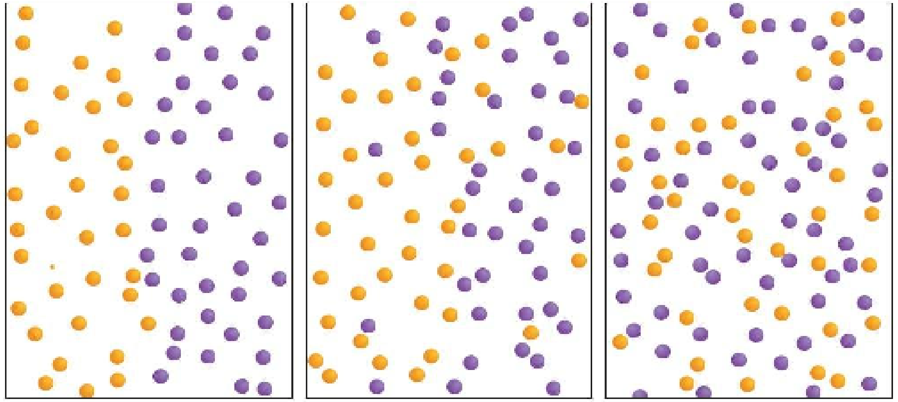
6	Explain how the particle movment and collision allow the spread of matter in terms of diffusion	Textbook, figures, investigation	12, 13, 14

Movement and Collisions In the Lab *Wait For It*, the food coloring moved when the water in the beaker appeared to be completely still. How did this happen? Water particles, like the particles in all liquids, constantly bump and flow past each other in **random motion**—movement in all directions and at different speeds. The movement and collisions of the water particles push the food coloring particles around, causing the coloring to spread out, or diffuse. **Diffusion** is the movement of particles from an area of higher concentration to an area of lower concentration. Diffusion does not happen instantly. Particles diffuse until the concentration is the same throughout the container. When the concentration of food coloring is the same throughout the container, the liquid is one color.

Take a look at the figure below. Notice that as you move from left to right, the particles become more diffuse.



What determines how much energy particles have?

You know that a rolling ball has energy because it is moving. Particles also move, so they also must have energy. Remember, energy is the ability to cause change. Is there a relationship between how fast a particle moves and the amount of energy it has? Let's investigate!

INVESTIGATION

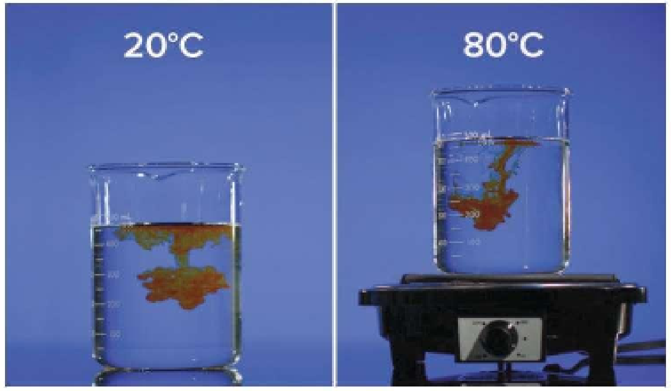
Ready, Set, Collide

GO ONLINE Watch the video *Dye Race* to investigate how adding energy affects particle movement. Record your observations below.

Students should record their observations. They should notice that dye in the beaker at the higher temperature diffuses more quickly than dye in the beaker at the cooler temperature.

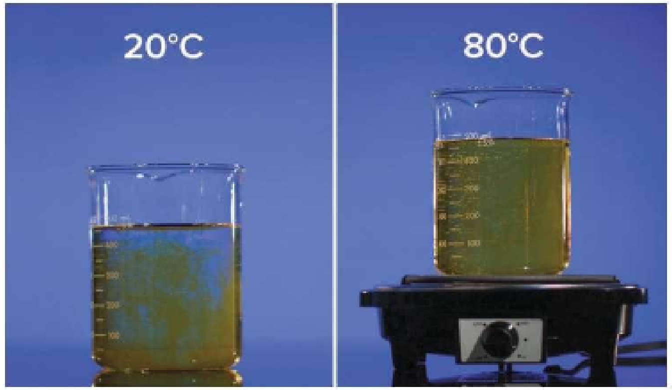
Use your observations from the video to draw conclusions about the figure below. What can you conclude about how adding energy to the liquid on the right will affect the speed of the particles?

Answers may vary. Sample answer: The dye diffused faster in the beaker at the higher temperature. So, the more energy that is added, the faster the particles move. If the particles are moving at a faster speed, they will collide more often and cause the dye particles to diffuse faster around the beaker.



6	Explain how the particle movment and collision allow the spread of matter in terms of diffusion	Textbook, figures, investigation	12, 13, 14

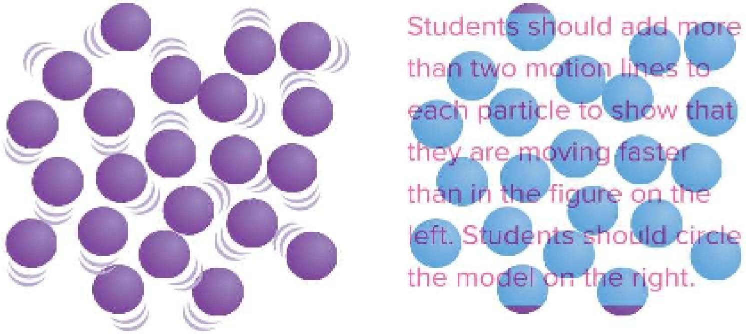
Movement and Energy Scientists use diffusion to observe how fast the particles of a substance are moving. The faster the substance diffuses, the faster the particles are moving. In the figure below, energy was added from the hot plate to the water and dye particles on the right. This added energy increased the motion energy, also called **kinetic energy,** of the particles. As the kinetic energy of the particles increased, the speed of the particles increased. The faster particles move, the more kinetic energy they have.



How to Model Movement Motion lines are used to model particle movement in a still image. Since particles travel at different speeds, they need to be represented by different numbers of motion lines. The more motion lines, the faster the particle is moving.

THREE-DIMENSIONAL THINKING

Add motion lines to the liquid particles **model** on the right to show they are moving faster than the liquid particles on the left. Circle the model that has more kinetic **energy.**

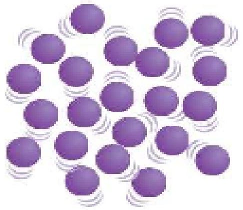


7	Define thermal expansion and thermal contraction and compare between them according to: energy change, tempreature, particle movment, volume, ... Etc.	textbook, figures, 3D	17, 18, 19

Energy and Volume As the temperature of a material increases, its particles move faster. They collide with each other more often and push each other farther apart. The increase in volume of a material when particle motion increases is known as **thermal expansion.** The opposite can also occur. A substance can lose kinetic energy and the particles will move slower. As they move slower, they collide with each other less often, which causes the substance to take up less space. This is known as thermal contraction. **Thermal contraction** happens when particle motion decreases and causes the particles to occupy less volume.

THREE-DIMENSIONAL THINKING

On the right, sketch a diagram to **model** what the particles on the left would look like if they went through thermal expansion. Circle the model that has more kinetic **energy.**



Students should draw the particles the same size but more spread out with more motion lines to indicate a higher temperature and a larger volume. Students should circle the model on the right.

Energy and Temperature The property of thermal expansion and contraction can be used to measure temperature. **Temperature** is the measure of the average kinetic energy of the particles in a material. The temperature of a substance depends on how much kinetic energy the particles that make up the material have. The lower the kinetic energy of the particles, the lower the temperature of the substance. One way to measure the relative amount of kinetic energy or speed of the particles is by measuring how much the substance expands or contracts.

GO ONLINE for additional opportunities to explore!

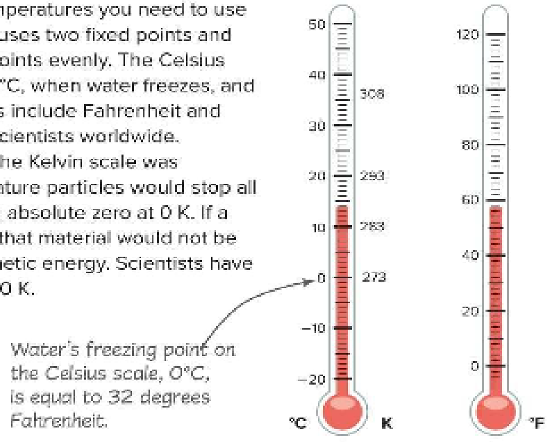
ENGINEERING Connection Investigate how thermometers use thermal contraction and thermal expansion to measure temperature.

☐ **Ask questions** to learn more about the history of thermometers after watching the **Animation** *How does a glass bulb thermometer work?*

OR

☐ **Develop a model** of a liquid thermometer using your own temperature scale in the **Lab** *Build Your Own Thermometer.*

Temperature Scales To compare temperatures you need to use the same temperature scale. A scale uses two fixed points and divides the space between the two points evenly. The Celsius scale is created with fixed points of 0°C, when water freezes, and 100°C, when water boils. Other scales include Fahrenheit and Kelvin. The Celsius scale is used by scientists worldwide. Scientists also use the Kelvin scale. The Kelvin scale was developed to predict at what temperature particles would stop all motion. This temperature is known as absolute zero at 0 K. If a material reaches 0 K, the particles in that material would not be moving and would no longer have kinetic energy. Scientists have not been able to cool any material to 0 K.



THREE-DIMENSIONAL THINKING

1. **Construct an explanation** about the relationship between average particle speed and temperature.

As particle speed increases, the temperature increases. As particle speed decreases, the temperature decreases. The relationship is proportional.

2. What conclusions can you make about kinetic **energy** and temperature?

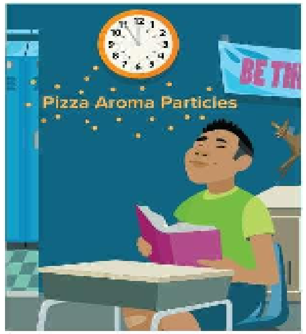
As the temperature of a substance increases, kinetic energy increases. As the temperature of a substance decreases, kinetic energy decreases.

COLLECT EVIDENCE

How could the temperature of the wood and metal blocks be measured? Record your evidence (B) in the chart at the beginning of the lesson.

7	Define thermal expansion and thermal contraction and compare between them according to: energy change, tempreature, particle movment, volume, ... Etc.	textbook, figures, 3D	17, 18, 19

How do particles in a gas behave compared to particles in a liquid?



Think about a time when you smelled what was for lunch even though you were not near the cafeteria. The entire school did not smell the lunch at the same time. The people nearby smelled it first. The scent traveled away from the cafeteria over time. You could smell lunch because gas particles move. They move in straight lines until they collide with something, like another gas particle. These collisions change the speed and direction of the particles' movements.

INVESTIGATION

It's a Gas

GO ONLINE Watch the video *Cold Balloon* and the animation *Particle Movement in Gases* to see how particles in gases behave. Complete the graphic organizer with your observations.

When the balloon was cooled, kinetic energy... decreased.	When the balloon returned to room temperature, kinetic energy... increased.
Gas particles inside the balloon... slowed down and moved closer.	Gas particles inside the balloon... sped up and moved farther apart.
Evidence of thermal... contraction.	Evidence of thermal... expansion.

Gas Particles In gases, particles move at high speeds and have high amounts of kinetic energy. Gases can expand and contract. Just like dye diffusing in a still beaker of water, being able to smell a scent over a distance is evidence for the movement of particles.

8	Plan an investigation to determine the relationships among the energy transferred in solids, the **mass**, the volume, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.	textbook, investigations, 3D	20, 24

What evidence is there that particles in a solid move?

Solids, like the wood and metal you observed at the beginning of the lesson, are often described as having a definite shape. They are not fluid like liquids and gases. This means the particles in a solid do not flow past each other. Do the particles in a solid move? Let's find out!

INVESTIGATION

Still Solid

GO ONLINE Watch the video *Metal Ring* to observe how particles in a solid behave when heated. Complete the graphic organizer with your observations.

When the metal ball was heated, kinetic energy... increased.	*When the metal ball returned to room temperature, kinetic energy...* decreased.
Solid particles inside the metal ball... vibrated faster and moved slightly apart.	*Solid particles inside the metal ball...* slowed down and moved back to their original locations.
Evidence of thermal... expansion.	*Evidence of thermal...* contraction.

Based on what you saw in the *Metal Ring* video, how do you think you could model the particles in a solid?

Answers may vary. Sample answer: You could model the particles really close to each other, but not really moving. You would still need to show that the particles move apart from each other.

Analyze and Conclude, continued

12. What claim can you make about the relationship between mass and energy? Use reasoning to explain how the evidence supports your claim.

Answers may vary. Sample answer: The greater the mass of a substance, the more energy the substance has. A substance with greater mass has a greater number of particles. The more particles that are present, the greater the energy of that substance.

THREE-DIMENSIONAL THINKING

A student left their half-full water bottle out in the Sun all day and would like to cool it down. They could add cool tap water to fill up their water bottle or they could add a small amount of cold water from the refrigerator. Present an **argument** on which option you would recommend. Support your recommendation with **evidence.**

Answers may vary. Sample answer: The student should use the cool tap water. The water from the refrigerator will have a lower temperature than the water from the tap. But, the tap water has a greater mass. In the lab I observed that a larger mass will cause a greater change in the temperature.

Energy and Mass Two substances have the same average kinetic energy by being at the same temperature. When one substance has more particles, that substance has more energy. For example, there are five times as many water particles in 100 grams of water than in 20 grams of water. If the temperatures of the two water samples are the same, the sample with more mass will contain more total energy. The more particles present, the more total energy present in a substance.

COLLECT EVIDENCE

How do the masses of the wood and metal blocks affect how much energy they have? Record your evidence (D) in the chart at the beginning of the lesson.

9	Diffrentiate between evaporation and bioling point	textbook, figure, table	40

Changes Between Gases and Liquids When the temperature of a gas becomes low enough, the gas changes to a liquid. The change of state from a gas to a liquid is **condensation.**

Water condenses on grass overnight

EARTH SCIENCE Connection Changes between states of matter drive the water cycle. Water changes from a liquid on the ground into a gas and enters the atmosphere. When the water vapor in the atmosphere undergoes condensation, it forms clouds. The overnight condensation of water vapor often causes dew to form on blades of grass.

Vaporization The opposite of condensation is **vaporization,** the change in state from a liquid to a gas. There are two ways that vaporization occurs, boiling and evaporation.

Evaporation	Boiling
Vaporization that occurs on the surface of a liquid is called evaporation. Evaporation can occur during boiling and at lower temperatures. A small amount of room-temperature water in a glass, for example, evaporates in a few days without ever reaching the boiling point temperature.	Vaporization that occurs within a liquid is called boiling. Boiling does not occur until a liquid is heated to its boiling point, the point where a substance changes from a liquid to a gas. Once the boiling point is reached, the continued addition of energy vaporizes the liquid. Bubbles form within a liquid as it boils.

The boiling point and the condensation point are the same for a given substance. Whether a liquid is changing to a gas or a gas is changing to a liquid, a substance will always change phases at the same temperature. While a substance is boiling or condensing, the temperature remains constant until the phase change is complete.

10	Differentiate between kinetic energy and potential energy	textbook, table, 3D	42, 43

3. In the graphic organizer below, circle the word that best describes what happens as heat is added to the solid.

Temperature of solid	Speed of particles	Distance between particles
increased (circled)	increased (circled)	increased (circled)
decreased	decreased	decreased
stayed the same	stayed the same	stayed the same

Particle Arrangement If energy is continually added to a substance, there reaches a point where the particles cannot go any faster without changing to another state of matter. Recall that particles in gases are fast moving and spread out from each other. In liquids, particles are closely packed but can slide past each other. In solids, the particles are closely packed and held in a rigid formation. The reason each state of matter has different shapes is because of the particle attractions in each state of matter.

Particle Attraction When energy is added and the particles cannot move any faster in the current state of matter, the energy is used to overcome the attraction between particles and causes a change of state. The additional energy increases the potential energy of the particles. **Potential energy** is stored energy due to the interactions between particles or objects. The potential energy increases as the distance between particles increases. Conversely, the potential energy decreases as the distance between the particles decreases. The particles that are farther apart have greater potential energy. The potential energy of the particles, determined by the state of matter present, contributes to the total energy of a substance.

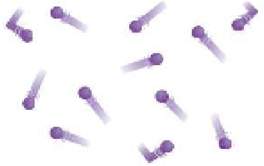
Kinetic Energy	Potential Energy
Relates to particle speed	Relates to the distance between particles/strength of attractions between particles
Measured by temperature of substance	Measured by state of matter
Increases as particle speeds increase	Increases as distance between particles increases
Decreases as particle speeds decrease	Decreases as distance between particles decreases
Increases as temperature increases	Increases as state of matter changes from solid to liquid to gas
Decreases as temperature decreases	Decreases as state of matter changes from gas to liquid to solid

THREE-DIMENSIONAL THINKING

For each example:

1. Complete the **model** of the particles.
2. Indicate how potential **energy** is changing (increasing or decreasing).
3. Indicate how the attractive forces are changing (increasing or decreasing).

A

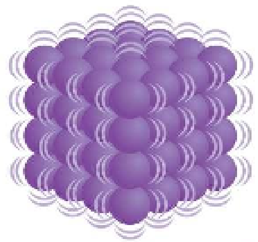


→ Condensing: Sketch of particles slowing down → Liquid: Sketch of particles in liquid state

Potential Energy = decreasing

Attractive Forces = increasing

B

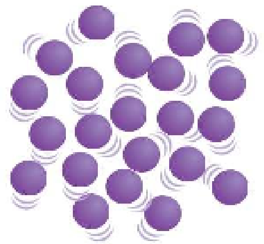


→ Melting: Sketch of particles speeding up → Liquid: Sketch of particles in liquid state

Potential Energy = increasing

Attractive Forces = decreasing

C

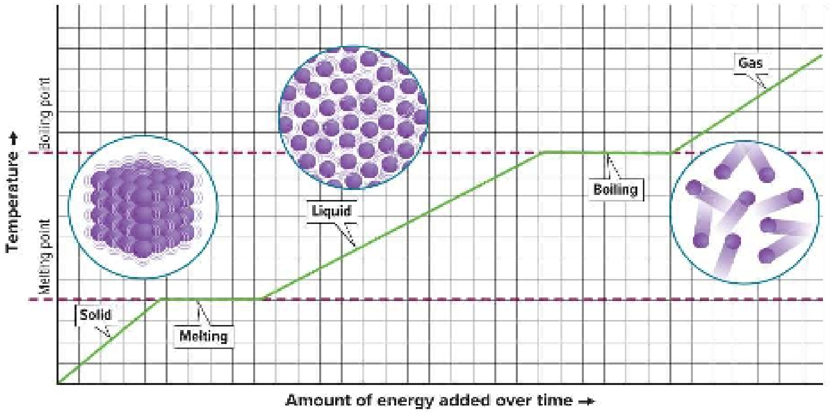


→ Boiling: Sketch of particles speeding up → Gas: Sketch of particles in gas state

Potential Energy = increasing

Attractive Forces = decreasing

11	Describe and identify the features of heating curve and explain the reason of all the parts of it	textbook, figures, 3D	44, 51



Heating Curves The graph above is the heating curve for water. Just as in the graphs you created, it shows what happens to temperature as energy is added to a substance. As energy is transferred to a material, temperature increases when the state of the material is not changing. The kinetic energy of the particles increases. This increases the speed of the particles.

When a substance is changing state, temperature stays the same at the melting and boiling. The potential energy of the particles increases. This increases the distance between the particles.

THREE-DIMENSIONAL THINKING

Construct an **argument** on how the existence of potential **energy** between particles supports or opposes the shape of a heating curve.

Answers may vary. Sample answer: When the state is changing, the energy is becoming potential energy. As temperature is a measure of the average kinetic energy, the temperature does not change because the average kinetic energy is not changing.

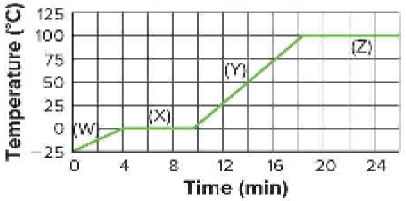
COLLECT EVIDENCE

How does the existence of potential energy and the attractions between particles help explain why gallium exists as different states of matter? Record your evidence (B) in the chart at the beginning of the lesson.

Three-Dimensional Thinking

The heating curve for water is shown below.

Temperature v. Time for Heating Water



2. Analyze the heating curve. Which area or areas of the curve show a change in the potential energy of the particles?

A W

B W and X

C X and Z

D Y

3. A scientist was working with substance Y. Which of the following does not represent an increase in thermal energy?

A The temperature of the substance rose by 10°C.

B The volume of the substance increased by 10 mL.

C The mass of the substance increased by 10 g.

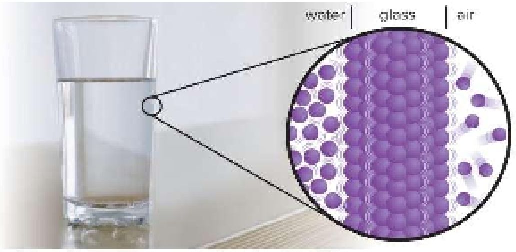
D The substance changed from a liquid into a solid.

12	Differentiate between the methods of heat transfers: Radiation, convection, and conduction. & give examples	textbook, figures	61, 65

Conduction Have you ever noticed that when you place a hot piece of toast on a plate, the plate becomes warmer? Thermal energy from the toast transfers to the plate through the process of conduction. **Conduction** is the transfer of thermal energy between materials by the collisions of particles. The particles in the hot toast are in contact and so collide with the particles of the plate. This causes the particles in the plate to gain thermal energy. Conduction can occur between solids, liquids, and gases.

FOLDABLES
Go to the Foldables® library to make a Foldable® that will help you take notes while reading this lesson.

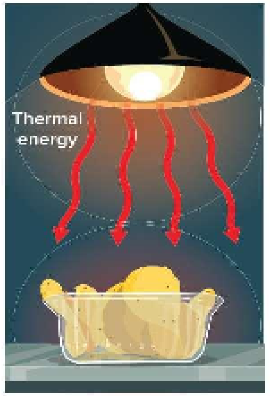
When particles at different temperatures collide, the particle with higher kinetic energy transfers energy to the particle with lower kinetic energy. This changes the motion of both of the particles. When the energy of a substance changes, there is always another change in energy at the same time. For example, if a particle transfers or loses kinetic energy, it will move slower. If a particle gains kinetic energy, it will move faster.



THREE-DIMENSIONAL THINKING
Look closely at the motion of the particles modeled in the image above. Use the energy flow diagram to model the components of the system that are transferring energy. Identify the type of energy involved and whether the energy increased or decreased.

Source Object	Receiver Object
glass	air
Thermal energy decreases	Thermal energy increases
Energy	Energy

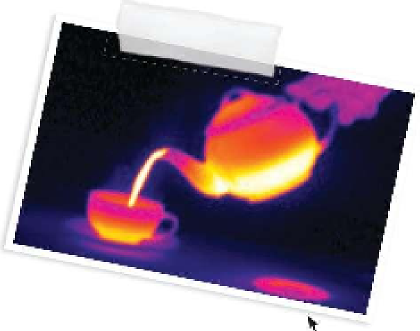
Radiation Another process that transfers energy is radiation. **Radiation** is the transfer of thermal energy from one material to another by electromagnetic waves. All matter, including the Sun, fire, and even you, transfers thermal energy by radiation. Warm objects emit more radiation than cold objects do.



A thermogram, like the one shown below and at the beginning of the lesson, is an image created by a technology that measures the radiation given off by objects. The thermogram below shows hot water pouring from a teapot into a cup. Objects giving off more radiation are shown in white, reds, and yellows, while cooler objects are shown with blues, purples, and black.

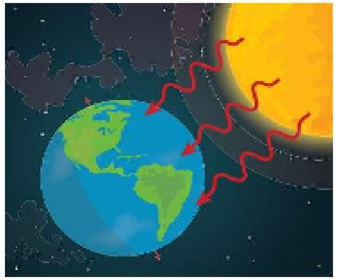
THREE-DIMENSIONAL THINKING
In the thermogram on the right, how do conduction and radiation explain the energy transfers occurring?

Conduction happened between the teapot and the table leaving behind a spot of high thermal energy when it was picked up. Radiation is happening on all objects.



What's happening here?

EARTH SCIENCE Connection Thermal energy from the Sun can only travel to Earth by radiation. This is because space is a vacuum—a space that contains little or no matter. Since there is little matter in space, thermal energy cannot transfer by conduction, which requires objects to be in contact. Radiation is the method of thermal energy transfer in space. However, radiation also can transfer thermal energy through solids such as rocks, liquids like the ocean, and gases in the atmosphere.

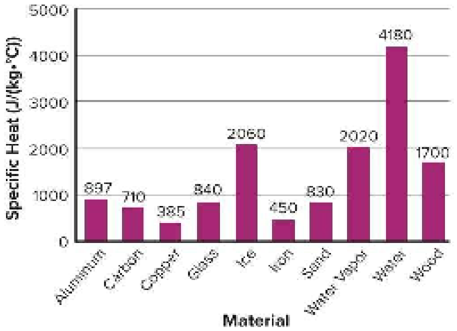


COLLECT EVIDENCE
How does radiation help explain the direction of thermal energy transfer between the toast and the environment? Record your evidence (B) in the chart at the beginning of the lesson.

13	Using bar graph Relate Specific heat of different materials to their ability in conducting heat (thermal conductor, thermal insulator)	textbook, graph	82, 83

Specific Heat The ratio that you found describes the specific heat of a substance. **Specific heat** is the amount of thermal energy required to increase the temperature of 1 kg of a material by 1°C . Every material has a specific heat. It does not take much energy to change the temperature of a material with a low specific heat compared to a material with a high specific heat. The chart below lists specific heats of various materials.

Specific Heats of Common Materials



GO ONLINE for additional opportunities to explore!

Want to know more about how a material affects thermal energy transfers? Investigate how specific heat determines which materials are used for keeping us cool or warm by performing one of the following activities.

☐ **Model** how energy transference is determined by types of materials in the **PhET Interactive Simulation** *Energy Forms and Change.*

OR

☐ **Argue** the use of home insulation after reading the **Scientific Text** *Insulating the Home.*

EARTH SCIENCE Connection You may have noticed that the specific heat of water is particularly high. A large amount of energy is needed to increase the temperature of water by 1°C. This characteristic of water has many benefits. The high specific heat of water is one of the reasons why pools, lakes, and oceans stay cool in summer. It also means that areas of land that are near large lakes or an ocean generally have more moderate climates. They are cooler in the summer and warmer in the winter because it takes a lot of energy to change the temperature of the water.

Conductors and Insulators Materials are classified into two groups based on their specific heats: conductors and insulators. A **thermal conductor** is a material through which thermal energy flows easily. The particles in a thermal conductor move easily so kinetic energy is transferred easily between particles. Metals are better thermal conductors than nonmetals. A **thermal insulator** is a material through which thermal energy does not flow easily. The particles in a thermal insulator do not move as easily so kinetic energy is not transferred easily between particles.

The handle of the pan in the figure on the right is made out of wood. Wood is a thermal insulator. The pan is made out of iron—a thermal conductor. Thermal conductors have lower specific heats than thermal insulators. This means it takes less thermal energy to increase the temperature of a thermal conductor than it takes to increase the temperature of a thermal insulator of the same mass.

THREE-DIMENSIONAL THINKING

You can bake food in either a metal pan or oven safe glass. Which would require more energy to heat up? Which would cool down the fastest? Explain your reasoning.

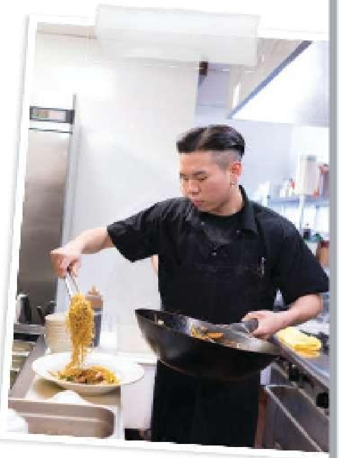
A glass dish would require more energy to heat up because it has a higher specific heat. The metal pan would cool down the fastest because it has a low specific heat.

COLLECT EVIDENCE

How does the type of material in the kitchenware affect how it transfers thermal energy? Record your evidence (B) in the chart at the beginning of the lesson.

What other properties affect thermal energy transfer?

The materials that make up a piece of matter and the mass of that matter affect how much thermal energy transfers. Kitchenware also comes in many different shapes and colors. There are thick cast iron skillets and thin aluminum pans, tall glasses and shallow bowls. Do these factors affect how much thermal energy transfers? Let's investigate!



14	Relate Thermal energy and properties of materials, factors and relate it to Albedo	Textbook, figures	86, 161, 163

Thermal Energy and Properties of Materials Many different properties of a substance can determine how thermal energy will transfer. Some properties include the reflectivity of a substance, the thickness of a substance, and the exposed surface area.

Reflectivity v. Absorbency	Thickness	Surface Area
Reflection is when energy carried by a wave bounces off a surface. The opposite of reflection is absorption, or the transfer of energy by a wave to a medium through which it travels. The color white reflects all radiated light energy while the color black absorbs all radiated light energy.	The thickness of a substance can determine how thermal energy is transferred. The thicker a substance, the larger the distance the thermal energy has to travel. A larger thickness could increase how long a substance takes to heat up and also delay how long it takes to cool down. Thickness relates to the mass of a substance.	Surface area is the amount of exposed, outer area of a substance. Increased surface area for a given volume increases the energy transfer between the substance and the surroundings. For example, a shallow bowl has more surface area than a deep bowl. The shallow bowl will transfer more thermal energy to the surroundings.

Many factors can affect how thermal energy is transferred between substances. The amount of energy needed to change the temperature of a matter sample by a given amount depends on the type of the matter, the size of the sample, and the environment.

THREE-DIMENSIONAL THINKING

Develop an **explanation** for which student in the image gains the most thermal **energy** from the environment.

The student in the darker colored shirt would gain more thermal energy from the environment because darker colors absorb more energy than light colors.

COLLECT EVIDENCE

How do other properties of the kitchenware affect how it transfers thermal energy? Record your evidence (C) in the chart at the beginning of the lesson.

15	Compare between thermal energy when changing through different states of matter (released or absorbed)	textbook, figure, 3D	119

Three-Dimensional Thinking

Jorge wanted to model two processes that cycle water in the atmosphere for a class project. He began by filling a self-sealing plastic bag half-full of water. After sealing the bag, he taped it to a sunny window. After a few hours, water beaded along the inside of the bag.

2. Which processes are represented by Jorge's model?

A transpiration and respiration

B condensation and crystallization

C respiration and evaporation

D evaporation and condensation

Examine the photo below.

3. Which statement best describes the transfer of energy in the photo above?

A When water changes state from a liquid to a solid, thermal energy is absorbed.

B When water changes state from a solid to a liquid, thermal energy is absorbed.

C When water changes state from a liquid to a solid, thermal energy is released.

D When water changes state from a solid to a liquid, thermal energy is released.

16	Define aquifers and ground water and lable them on digram	Textbook, figure, 3D	131, 132

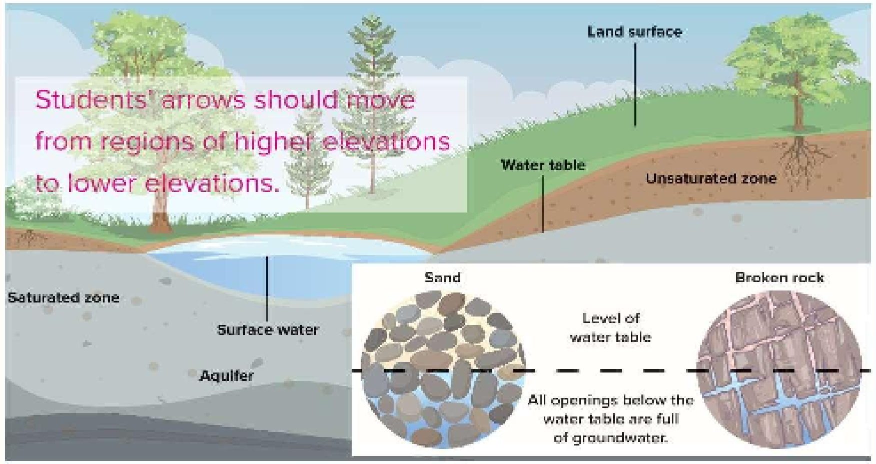
Where is water stored?

You discovered in the *Streaming By* investigation that gravity acts on precipitation, causing water on and below Earth's surface to continuously flow downhill toward the ocean. Although water is constantly moving through the water cycle, most water remains in certain storage areas for relatively long periods of time. A storage area is called a reservoir. Reservoirs can be oceans, lakes, glaciers and ice caps, and groundwater.

Water Under Your Feet Generally, water that lies below ground is called groundwater. There is an immense amount of water below our feet in **aquifers**—areas of permeable sediment or rock that hold significant amounts of water. As you observed in *Streaming By*, water seeps through soil and into tiny pores, or spaces, between sediment and rock. How do you think water moves underground?

THREE-DIMENSIONAL THINKING

1. Draw arrows on the figure below to **model** how you think groundwater might flow.



2. Read the first paragraph on the following page and revise your arrows as needed.

3. What force **causes** groundwater to flow?

Gravity causes groundwater to flow downhill.

Groundwater Flow Groundwater flows from higher elevations to lower elevations, and ultimately to the ocean. In some areas, groundwater is very close to the surface and keeps the soil wet. In other areas, especially deserts and other dry climates, groundwater is hundreds of meters below the surface.

LIFE SCIENCE Connection Oases—fertile lands in the desert—are usually formed when underground water gets close to the surface. When this happens, springs turn a normally arid place into an area where plants can thrive. In low-lying areas at Earth's surface, groundwater might eventually seep out of the ground and into a stream, a lake, or a wetland. In this way, groundwater can become surface water. Likewise, surface water can seep into the ground and become groundwater. This is how groundwater is replenished.

COLLECT EVIDENCE

How does water become groundwater and where else is water stored? Record your evidence (C) in the chart at the beginning of the lesson.

GO ONLINE for additional opportunities to explore!

ENVIRONMENTAL Connection To learn more about how humans rely on and affect water resources, perform one of the following activities.

___ **Model** the behavior of groundwater in the **Lab** *How does pollution impact the water cycle?*

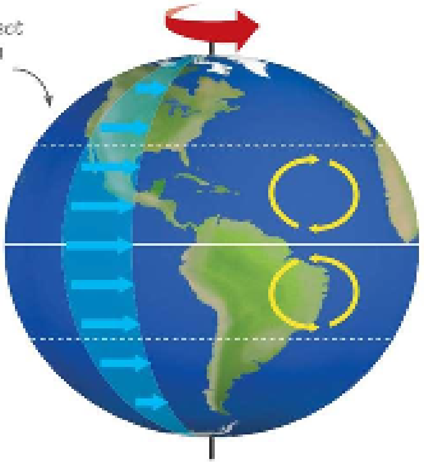
OR

___ **Argue** the issue of water diversion in the **STEM Activity** *Freshwater Transportation Debate.*

17	Define Coriolis Effect and explain the reson for their occurance	Textbook, figure	181

Rotation of Earth What do you think happens when you throw a ball to someone across from you on a moving merry-go-round? The ball appears to curve because the person catching the ball had moved. In a similar way, Earth's rotation causes moving air and water to appear to curve to the right in the Northern Hemisphere and to the left in the Southern Hemisphere, a phenomenon known as the **Coriolis effect.** As you just investigated, the Coriolis effect describes how objects and fluid matter, like air and water, move in an apparent curved path rather than a straight line. It is the Coriolis effect that produces the curving patterns of circulating wind.

How does the Coriolis effect deflect air (and water) on Earth's surface?



1. Air is being carried around Earth by rotation. The surface has a greater velocity near the equator than at the poles because it has to travel a greater distance in 24 hours.

2. Therefore, as air moves toward the poles, it is rotating faster toward the east than the land over which it moves. It appears from the surface to be deflected to the east.

3. The opposite occurs as air moves toward the equator and encounters areas with a faster surface velocity. The air appears to lag behind, deflecting to the west as if it were being left behind by Earth's rotation.

Effect of Landmasses The Coriolis effect is not the only factor that influences the motion of wind. Landmasses also affect the speed and direction of wind systems. For example, the westerlies in the Southern Hemisphere are locally very strong because this system is mostly over the oceans and has few continents to disrupt the wind.

Additionally, when wind meets a large feature, such as a mountain, it is deflected, or forced, upward, as shown in the photo to the right.

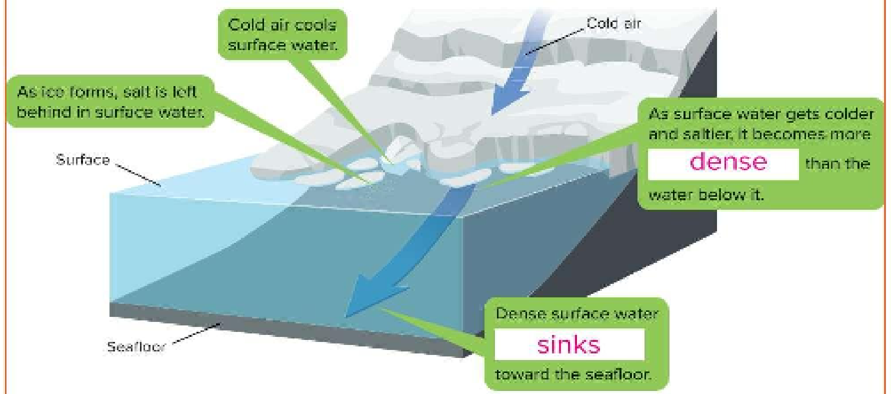
18	Explain how density current oocurs	textbook, figure, 3D	184

Density Currents In the previous activity you discovered that high salinity and cold temperatures cause water to become more dense. Like air, water that is more dense sinks. This helps create currents of water deep in the ocean as water flows from areas of high density to areas of low density. A **density current** is the vertical movement of water caused by differences in density.

THREE-DIMENSIONAL THINKING

Examine the diagram **modeling** the formation of a density current below.

1. Complete the sentences on the image.



2. With a partner, identify the components of this **system**.

Components include the atmosphere, water, salt, continents, thermal energy, and ice.

3. Based on what you know about density currents, where do you think they form?

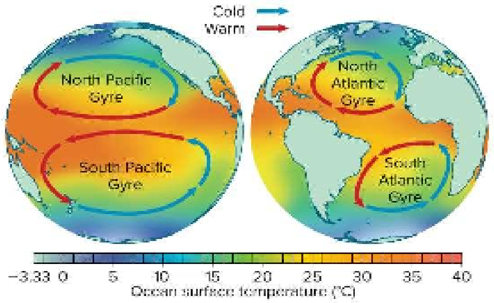
Sample answer: Density currents likely form in polar areas where cold, dense salt water sinks toward the seafloor.

19	illustrate why ocean currents flow in certain direction, and recognaise the global pattern that they form	textbook, figures, investigation, 3D	189, 190

Influencing Factors As you just modeled in the *Toys Ahoy* lab, landmasses deflect the flow of ocean currents. They help create large circular systems of ocean currents called gyres. As shown on the map below, the currents within each gyre move in the same direction. However if you look closely, you can see that the direction of current movement in a gyre is different in each hemisphere.

THREE-DIMENSIONAL THINKING

Analyze the map of gyres below. Then answer the questions that follow.



1. In what direction do gyres flow in the Northern Hemisphere? What about in the Southern Hemisphere? Why do you think this **pattern** occurs?

Gyres in the Northern Hemisphere circle clockwise and gyres in the Southern Hemisphere circle counterclockwise. This pattern is the result of the Coriolis effect.

2. Why are the major warm-water currents on the western boundaries of oceans and the major cold-water currents on the eastern boundaries of oceans? What explains this **pattern?**

Because of the Coriolis effect, water flowing from the equator toward the poles are on the western boundaries of oceans, and water flowing from polar regions toward the equator are on the eastern boundaries of oceans.

3. What **energy** ultimately drives convection in the oceans?

Solar energy drives convection in the oceans.

What global pattern do ocean currents form?

Aside from gyres, there is another large system of ocean currents that circulate thermal energy around Earth. Let's take a look.

INVESTIGATION

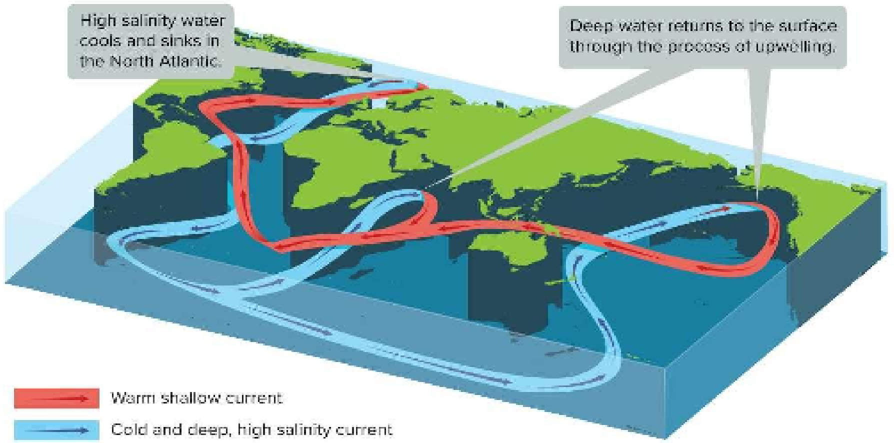
The Great Ocean Conveyor Belt

GO ONLINE to watch the animation *Great Ocean Conveyor Belt.*

What is the Great Ocean Conveyor Belt and what does it affect?

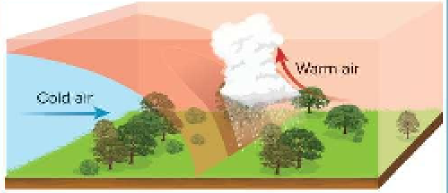
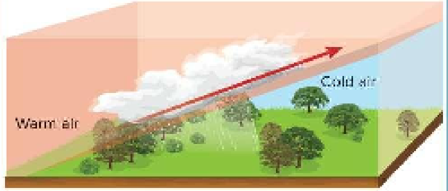
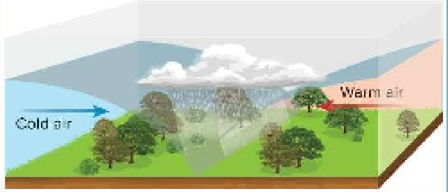
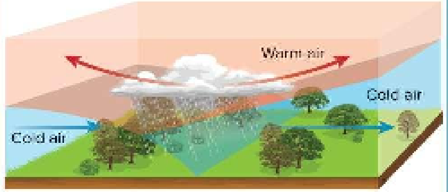
The Great Ocean Conveyor Belt is a model that explains how ocean currents circulate thermal energy around Earth affecting weather and climate.

Global Conveyor Belt Surface currents, upwelling, and density currents combine to form the Great Ocean Conveyer Belt, shown below. Variations in temperature and salinity drive this global pattern of interconnected ocean currents.



20	Compare between different types of fronts (air mass collision)	textbook, figures, table	213

Fronts You just learned about what happens at warm and cold fronts and the resulting weather. Two other types of fronts, stationary and occluded, are also common. Let's examine each type of front in the table below.

Type of Front	Diagram
Cold A cold front forms when a colder air mass moves toward a warmer air mass. The cold, denser air pushes underneath the warm, less dense air mass. The warm air rises and cools. Water vapor in the air condenses and clouds form.	
Warm A warm front forms when less dense, warmer air moves toward colder, denser air. The warm air rises as it glides above the cold air mass. The water vapor in the air condenses, creating a wide blanket of clouds.	
Stationary Sometimes an approaching front will stall for several days with warm air on one side of it and cold air on the other side. When the boundary between two air masses stalls, a stationary front forms. Cloudy skies and light rain are found along stationary fronts.	
Occluded Cold fronts move faster than warm fronts. When a fast-moving cold front catches up with a slow-moving warm front, an occluded front forms. Occluded fronts usually bring precipitation.	

Weather Associations Weather is often associated with pressure systems. Because air moves from high pressure to low pressure, the air inside the high-pressure system moves away from the center. Warm, dense air sinks, bringing clear skies and fair weather. In a low-pressure system, the air rises causing water vapor to condense. Let's investigate further!

Paper Part أسئلة مقالية

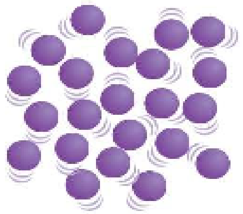
Paper part - الأسئلة المقالية	1	Determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.	Textbook, figures	17, 21
	2	Compare between the different three states of matter and the processes that change between them	Textbook, figure, invetigation	44, 45
	3	Explain how thermal energy transfer, and compare between closed and open systems, and assign source and received objects	Textbook, energy flow diagrams, lab	59, 60, 61,63
	4	Describe the relationship between thermal energy transfer and mass, represent this relationship in diagram (draw it)	textbook, figures, 3D	78
	5	1. Assign all the processes that is involved in the water cycle on a digram 2. label the global wind system, the convection cell and lines of latitude	textbook, figures, investigations	111, 112, 116 & 153, 177, 178

1	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.	Textbook, figures	17, 21

Energy and Volume As the temperature of a material increases, its particles move faster. They collide with each other more often and push each other farther apart. The increase in volume of a material when particle motion increases is known as **thermal expansion.** The opposite can also occur. A substance can lose kinetic energy and the particles will move slower. As they move slower, they collide with each other less often, which causes the substance to take up less space. This is known as thermal contraction. **Thermal contraction** happens when particle motion decreases and causes the particles to occupy less volume.

THREE-DIMENSIONAL THINKING

On the right, sketch a diagram to **model** what the particles on the left would look like if they went through thermal expansion. Circle the model that has more kinetic **energy.**



Students should draw the particles the same size but more spread out with more motion lines to indicate a higher temperature and a larger volume. Students should circle the model on the right.

Energy and Temperature The property of thermal expansion and contraction can be used to measure temperature. **Temperature** is the measure of the average kinetic energy of the particles in a material. The temperature of a substance depends on how much kinetic energy the particles that make up the material have. The lower the kinetic energy of the particles, the lower the temperature of the substance. One way to measure the relative amount of kinetic energy or speed of the particles is by measuring how much the substance expands or contracts.

GO ONLINE for additional opportunities to explore!

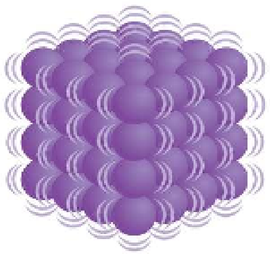
ENGINEERING Connection Investigate how thermometers use thermal contraction and thermal expansion to measure temperature.

☐ **Ask questions** to learn more about the history of thermometers after watching the **Animation** *How does a glass bulb thermometer work?*

OR

☐ **Develop a model** of a liquid thermometer using your own temperature scale in the **Lab** *Build Your Own Thermometer.*

Solid Particles The particles in a solid do not have the same freedom to move around like liquid and gas particles. In a solid, the particles vibrate back and forth in place. Since solid particles only vibrate, they have low amounts of kinetic energy. Expansion and contraction in solids does occur. However, it is less noticeable because the particles are holding each other in place.



COLLECT EVIDENCE

How could models of the particles in the wood and metal blocks show why one felt colder than the other? Record your evidence (C) in the chart at the beginning of the lesson.

How does the total amount of a substance affect its energy?

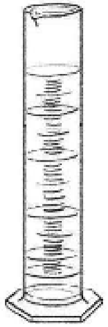
You have learned that particles have kinetic energy due to motion. Kinetic energy can be measured by comparing temperatures of substances. Kinetic energy is just one part of the total energy that a substance contains. In this lab you will add different amounts of water at different temperatures to the same amount of room temperature water. How do you think this will affect the kinetic energy of the water? Let's see what happens.

LAB In Hot Water

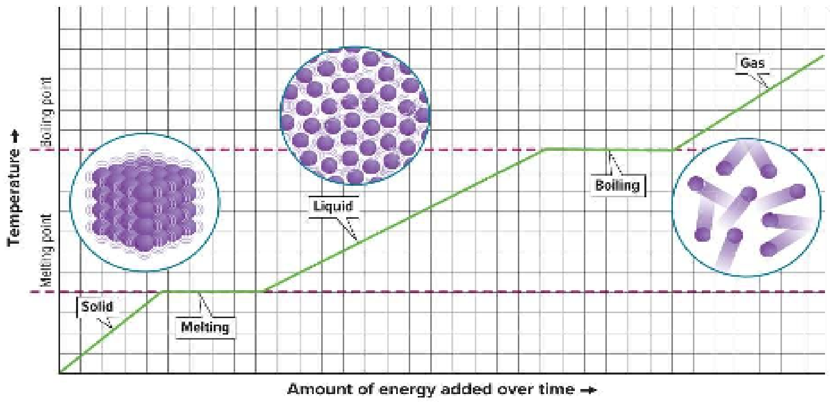
Safety

Materials

beakers (4)
room temperature water
30°C water
50°C water
thermometers (2)
graduated cylinder
balance
stopwatch



2	Compare between the different three states of matter and the processes that change between them	Textbook, figure, invetigation	44, 45



Heating Curves The graph above is the heating curve for water. Just as in the graphs you created, it shows what happens to temperature as energy is added to a substance. As energy is transferred to a material, temperature increases when the state of the material is not changing. The kinetic energy of the particles increases. This increases the speed of the particles.

When a substance is changing state, temperature stays the same at the melting and boiling. The potential energy of the particles increases. This increases the distance between the particles.

THREE-DIMENSIONAL THINKING

Construct an **argument** on how the existence of potential **energy** between particles supports or opposes the shape of a heating curve.

Answers may vary. Sample answer: When the state is changing, the energy is becoming potential energy. As temperature is a measure of the average kinetic energy, the temperature does not change because the average kinetic energy is not changing.

COLLECT EVIDENCE

How does the existence of potential energy and the attractions between particles help explain why gallium exists as different states of matter? Record your evidence (B) in the chart at the beginning of the lesson.

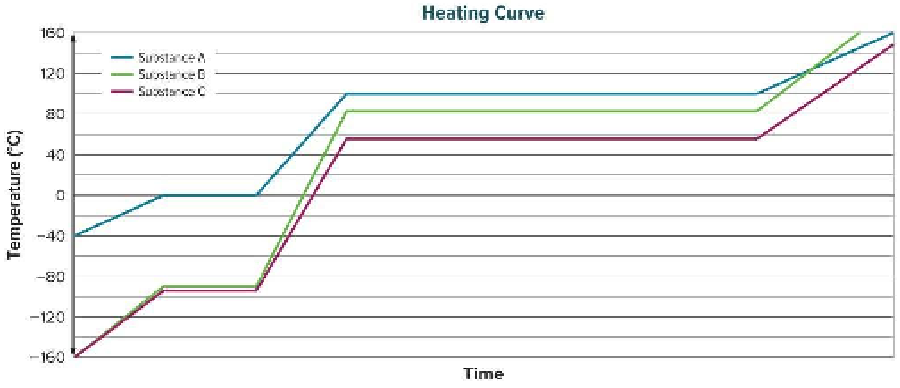
How do the melting and boiling points of different substances compare?

You know that ice melts at 0°C and liquid water boils at 100°C. Based on what you have learned so far, think about what you might expect the melting point of gallium to be.

INVESTIGATION

Turn Up the Heat

A group of students collected data using a similar procedure as the lab *Phase Changes*. They tested 100 mL of three different substances. The plot below was compiled from their data.



1. What patterns do you notice about the plot?

Answers may vary. Sample answer: All the substances change state in the same way or at the same rate. Each substance stays a single temperature as it changes state.

2	Compare between the different three states of matter and the processes that change between them	Textbook, figure, invetigation	44, 45

2. Complete the table below using the data plot.

Substance	Melting Point (°C)	Boiling Point (°C)
A	0°C	100°C
B	–90°C	85°C
C	–95°C	55°C

3. Make a claim about the melting and boiling points of different substances supported by evidence and reasoning.

Answers may vary. Sample answer: Different substances have different melting and boiling points. The particles of different substances hold together and separate at different temperatures.

4. At which temperatures are the potential energies of substances A, B, and C changing?

For substance A, the potential energy changes at 0°C and 100°C. For substance B, it changes at –90°C and 85°C. For substance C, the potential energy changes at –95°C and 55°C.

Particles and Melting Points Each substance has a unique melting and boiling point temperature. This is because the particles that make up each substance have different attractions for each other. The more attracted these particles are to each other, the more energy it takes to increase the distance between particles. This results in higher melting and boiling points. The type of particles that make up a substance affect how much energy is needed to cause a change of state. This is why different substances are in different states at the same temperature.

Water, butter, and aluminum change state at different temperatures.

COLLECT EVIDENCE

Why does gallium change from a solid to a liquid at a different temperature than ice changes to liquid water? Record your evidence (C) in the chart at the beginning of the lesson.

3	Explain how thermal energy transfer, and compare between closed and open systems, and assign source and received objects	Textbook, energy flow diagrams, lab	59, 60, 61,63

Data and Observations

Time (min)	Temp. of Water in large beaker (°C)	Temp. of Water in small beaker (°C)	Temp. of Air (°C)
0			
1			
2			
3			
4			
5			

Analyze and Conclude

8. Identify any patterns in the data.

Patterns could include: the temperature of the water in the large beaker increased every minute, in the small beaker temperature decreased every minute, and the air temperature was constant.

9. Why was it important to measure the temperature of the water in both beakers and the air in the classroom throughout the lab?

To see if the beakers gained thermal energy from the air inside the room. If they did, the air in the room would have gotten colder.

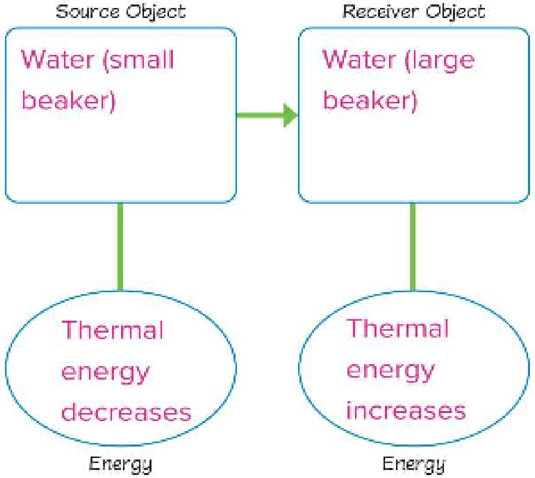
Systems and Energy The two beakers from the Lab *Transferring Temperature* represent a system. Systems are used to model the movement of energy. A **closed system** is a system that does not exchange matter or energy with the environment. Some situations can be thought of as closed systems, such as thermal energy transfers inside a microwave. In reality, there are no closed systems. The microwave is attached to an electrical outlet. Every physical system transfers some energy to or from its environment. An **open system** is a system that exchanges matter or energy with the environment.

The vegetables and microwave represent a system.

Objects make up the components of a system. Energy flows between the objects. The object that provides the energy for energy transfer is called the **source object.** The object that gains the energy from the energy transfer is called the **receiver object.**

THREE-DIMENSIONAL THINKING

Use the **energy** flow diagram to **model** the components of the **system** found in the Lab *Transferring Temperature*. Identify the type of energy involved and whether the energy increased or decreased.



Direction of Thermal Energy Transfer All substances contain thermal energy. When two substances contain different amounts of thermal energy, energy can transfer between the substances. The amount of thermal energy transferred from a region of higher temperature to a region of lower temperature is **heat.** Heat can also refer to the amount of energy transferred during this process.

It is not possible to make something colder by adding "coldness" to it. A substance can only be cooled by allowing some of its energy to be transferred to a substance of a lower temperature. For example, liquid water transfers energy to the surrounding air in a freezer in order to freeze.

THREE-DIMENSIONAL THINKING

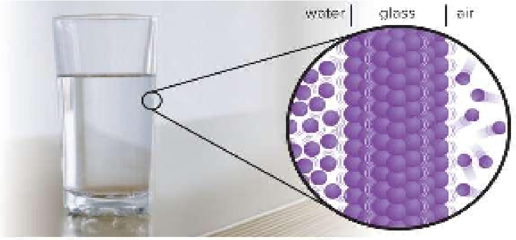
In the figure above, the water in the ice cube tray is 10°C. It is placed in the freezer at 0°C. Add arrows to the figure to **model** the direction of **energy** transfer.

3	Explain how thermal energy transfer, and compare between closed and open systems, and assign source and received objects	Textbook, energy flow diagrams, lab	59, 60, 61,63

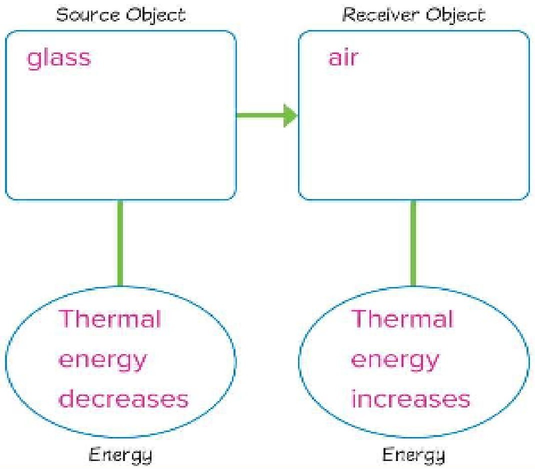
Conduction Have you ever noticed that when you place a hot piece of toast on a plate, the plate becomes warmer? Thermal energy from the toast transfers to the plate through the process of conduction. **Conduction** is the transfer of thermal energy between materials by the collisions of particles. The particles in the hot toast are in contact and so collide with the particles of the plate. This causes the particles in the plate to gain thermal energy. Conduction can occur between solids, liquids, and gases.

FOLDABLES
Go to the Foldables® library to make a Foldable® that will help you take notes while reading this lesson.

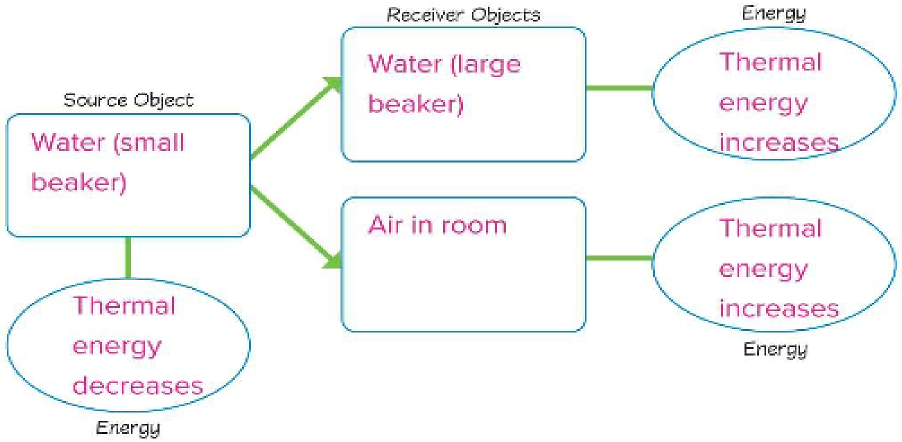
When particles at different temperatures collide, the particle with higher kinetic energy transfers energy to the particle with lower kinetic energy. This changes the motion of both of the particles. When the energy of a substance changes, there is always another change in energy at the same time. For example, if a particle transfers or loses kinetic energy, it will move slower. If a particle gains kinetic energy, it will move faster.



THREE-DIMENSIONAL THINKING
Look closely at the motion of the particles modeled in the image above. Use the energy flow diagram to model the components of the system that are transferring energy. Identify the type of energy involved and whether the energy increased or decreased.



7. Complete the energy flow diagram to identify the components of the open system, the type of energy involved, and whether the energy increased or decreased.



Thermal Equilibrium When the temperatures of materials that are in contact are the same, the materials are said to be in **thermal equilibrium.** After the materials reach thermal equilibrium, the particles that make up the water, the beaker, and the air continue to collide with each other. The particles transfer kinetic energy back and forth, but the average kinetic energy of all the particles remains the same.

COLLECT EVIDENCE

How does identifying the components in a system help explain the direction of thermal energy transfer between the toast and the environment? Record your evidence (A) in the chart at the beginning of the lesson.

How does thermal energy transfer when objects are not in contact?

How does a toaster heat the toast? If you have ever taken a look at the inside of a toaster you might have noticed that the heating coils never touch the bread. If the coils do not come into contact with the toast, then the toast cannot be heated by conduction. How else can thermal energy be transferred?

4	Describe the relationship between thermal energy transfer and mass, represent this relationship in diagram (draw it)	textbook, figures, 3D	78

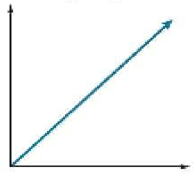
Analyze and Conclude, continued

11. Describe the relationship between the two variables.

As mass increases, the temperature change decreases.

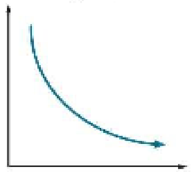
Thermal Energy Transfers and Mass Recall that mass is one of the factors that determines the amount of thermal energy in a substance. It takes more energy from the surroundings to increase the kinetic energy of the particles if there are more particles. As mass increases, the change in temperature will decrease for the same energy input. This is an inversely proportional relationship. Identifying proportional relationships provides information about different properties. For instance, knowing that change in temperature v. mass is an inversely proportional relationship would help answer a problem on whether it's faster to heat up a small pot of water or a large pot of water.

Directly Proportional



x increases, *y* increases

Inversely Proportional



x increases, *y* decreases

THREE-DIMENSIONAL THINKING

Sketch a particle **model** to explain the relationship between change in temperature and mass.

Models should show that the greater the mass of the substance the more thermal energy is needed to increase its temperature.

COLLECT EVIDENCE

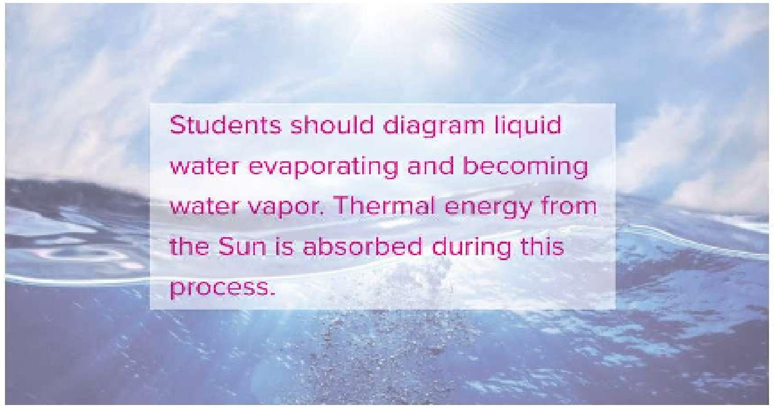
How does the mass of a material in the kitchenware affect how it transfers thermal energy? Record your evidence (A) in the chart at the beginning of the lesson.

5	1. Assign all the processes that is involved in the water cycle on a digram 2. label the global wind system, the convection cell and lines of latitude	textbook, figures, investigations	111, 112, 116 & 153, 177, 178

PHYSICAL SCIENCE Connection Water does not actually disappear from a puddle or a cloud. It evaporates. **Evaporation** is the process by which a liquid, such as water, changes into a gas. When the Sun shines on a body of water, water near the surface absorbs thermal energy and becomes warmer. As a molecule of water absorbs energy, it begins to vibrate faster. When it has enough energy, it breaks away from other water molecules. It rises into the atmosphere as a particle of gas called water vapor. Like other gases in the atmosphere, water vapor is invisible.

THREE-DIMENSIONAL THINKING

On the figure below, **model** the process that changes liquid water to water vapor. Label the transfer of **energy** that takes place during this process.



How does **energy** from the Sun drive the cycling of **matter?**

Thermal energy from the Sun causes liquid water on or near Earth's surface to evaporate and become water vapor.

COLLECT EVIDENCE

Why do clouds and other bodies of water "disappear?" Record your evidence (A) in the chart at the beginning of the lesson.

How else can water enter the atmosphere?

In the *Into Thin Air* lab, you learned that energy from the Sun drives evaporation on Earth's surface. Oceans hold most of Earth's water, so they are major sources of water vapor. But, water also evaporates from landforms such as rivers and lakes, or even puddles and soil. These sources, along with oceans, account for 90 percent of the water that enters the atmosphere. Where might the remaining 10 percent come from?

LIFE SCIENCE Connection

Plants and animals also contribute to the cycling of water on Earth. All living organisms rely on freshwater. In most plants, water travels from the roots up through the stems and into the leaves. When plants have an abundant water supply or experience increasing air temperatures, they release water vapor into the atmosphere. This usually occurs through the leaves. The process by which plants release water vapor into the atmosphere is called **transpiration.**

Some water vapor also comes from organisms through cellular respiration. During this process, food molecules are broken down and carbon dioxide and water are released as waste. When animals, such as this deer, breathe out, they release this carbon dioxide and water vapor from their lungs into the atmosphere. Plants also release water, as well as oxygen, through openings in their leaves.

Water is also stored in the tissues of plants and animals. This water is released back to the environment when organisms die and decompose.

COLLECT EVIDENCE

How else does water enter the atmosphere? Record your evidence (B) in the chart at the beginning of the lesson.

5	1. Assign all the processes that is involved in the water cycle on a digram 2. label the global wind system, the convection cell and lines of latitude	textbook, figures, investigations	111, 112, 116 & 153, 177, 178

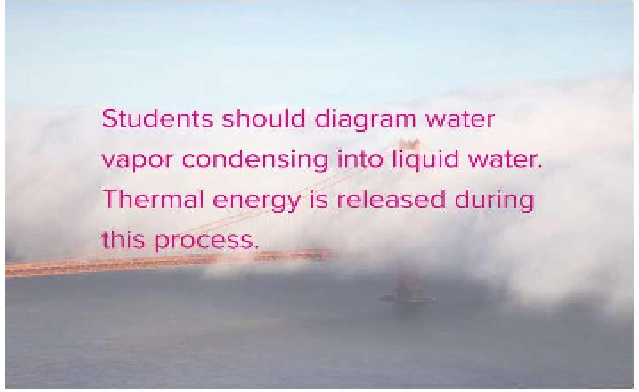
PHYSICAL SCIENCE Connection In the *Out of Thin Air* lab, you discovered that water vapor becomes liquid water as it cools. When you exhale outside on a cold winter day, you can see the water vapor in your breath condense into a foggy cloud in front of your face. This also happens when warm air containing water vapor cools as it rises in the atmosphere. Temperatures in the atmosphere near Earth decrease with increasing altitude. So, as water vapor rises through the atmosphere, it becomes cooler. Eventually it loses enough thermal energy that it returns to the liquid state.

The process by which a gas changes to a liquid is **condensation.** Water vapor condenses on small particles in the air and forms droplets. Sometimes the water droplets in the atmosphere lose so much thermal energy that tiny ice crystals form. The process by which a liquid turns into a crystalline solid is called **crystallization.** Recall that energy is absorbed during evaporation. When water changes state from a gas to a liquid, or from a liquid to a solid, energy is released.

When these small particles are surrounded by thousands of other droplets or ice crystals, they block and reflect light. This makes them visible as clouds or fog.

THREE-DIMENSIONAL THINKING

On the figure below, **model** the process that changes water vapor to liquid water. Label the transfer of **energy** that takes place during this process.



COLLECT EVIDENCE

How do clouds form? Record your evidence (C) in the chart at the beginning of the lesson.

Analyze and Conclude

8. Make a claim about how the shape of Earth affects incoming solar radiation.

Sample answer: Earth's spherical shape causes an unequal distribution of sunlight on Earth's surface.

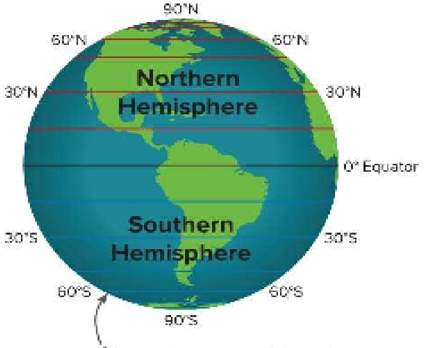
9. What evidence from the investigation supports your claim?

The light is more spread out near the balloon's top and bottom. The balloon is slanted relative to the flashlight beam near the top and the bottom. The light is more directed at the balloon's center.

10. Use your model to explain why Earth is warmer near the equator and colder near the poles.

Solar energy is more concentrated at Earth's equator and more spread out at Earth's poles because different parts of Earth's surface are curved relative to light from the Sun.

Solar Energy Distribution The angle of incoming sunlight depends largely on latitude. **Latitude** is the distance in degrees north or south of the equator. In latitudes near the equator—an area referred to as the tropics—sunlight strikes Earth's surface at a nearly 90° angle year-round. As a result, there is more sunlight per unit of surface area and the tropics are warmer than other areas on Earth. At latitudes near the North Pole and the South Pole, sunlight strikes Earth's surface at a low angle. Sunlight is now spread over a larger surface area than in the tropics. As a result, the poles receive very little energy per unit of surface area and are cooler.



Lines of latitude are parallel circles. The equator is the largest circle.

COLLECT EVIDENCE

Would the temperatures of the containers in the opening activity vary depending on where they were placed on Earth? Record your evidence (B) in the chart at the beginning of the lesson.

5	1. Assign all the processes that is involved in the water cycle on a digram 2. label the global wind system, the convection cell and lines of latitude	textbook, figures, investigations	111, 112, 116 & 153, 177, 178

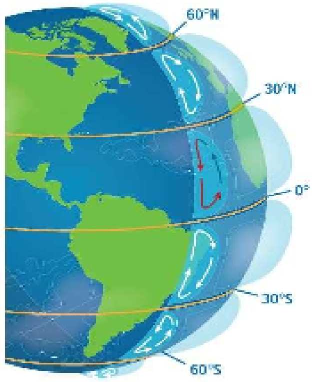
What patterns do global winds form?

PHYSICAL SCIENCE Connection Recall that conduction occurs where the atmosphere contacts Earth. As molecules of air close to Earth's surface are heated by conduction, they spread apart, and air becomes less dense. Less dense air rises, transferring thermal energy to higher altitudes. The transfer of thermal energy by the movement of particles within matter is called **convection.**

Earth has several large convection cells that redistribute thermal energy around the world. Let's take a look at global convection in Earth's atmosphere.

INVESTIGATION

Rise and Fall, then Repeat



1. Study the diagram. Notice the direction of air flow in each convection cell. What general patterns can you identify?

Students should notice that air rises and sinks in predictable patterns.

2. Using your knowledge of conduction and convection, color the arrows of the cells red for warm or blue for cool. Some have already been colored in for you.

3. Why do you think air rises and sinks in global convection cells?

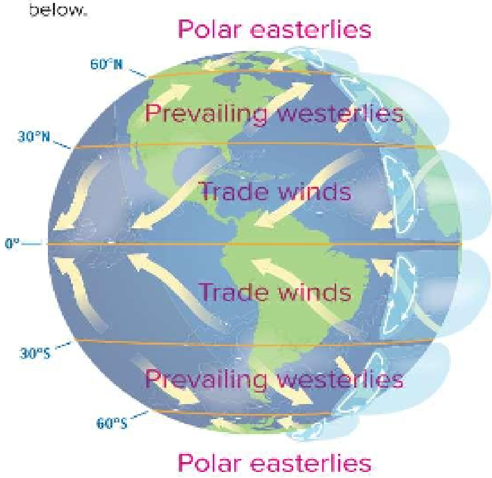
Warm air rises and flows north and south, away from the equator. Air at the surface flows toward the equator to replace the air that rises. This flow of warm air is balanced by the flow of cold air from the poles toward the equator.

Global Winds Global convection cells help generate the three basic wind systems at Earth's surface in each hemisphere. In the following activity, you will explore the trade winds, westerlies, and polar easterlies.

INVESTIGATION

It's a Blowin'

1. Label the image with the global wind systems based on the descriptions below.



- The **polar easterlies** are cold winds that blow from east to west near the North Pole and the South Pole. Polar easterlies begin as dense polar air that sinks.
- The **prevailing westerlies** are steady winds that flow from west to east between latitudes 30°N and 60°N, and 30°S and 60°S.
- The **trade winds** are steady winds that flow from east to west between 30°N latitude and 30°S latitude.

2. In which direction do you think weather generally moves across the United States? Why?

Most of the continental United States falls in the westerlies wind belt. The westerlies flow from west to east causing weather patterns to typically move west to east.

Can you tell which direction the wind typically blows here?