تجميعة أسئلة وفق الهيكل الوزاري منهج انسباير

موقع المناهج ⇦ المناهج الإماراتية ⇦ الصف السادس ⇦ علوم ⇦ الفصل الأول ⇦ ملفات متنوعة ⇦ الملف

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المزيد من مادة علوم:	ملفات ا كتب للمعلم ا كتب للطالب ا اختبارات الكترونية ا اختبارات ا حلول ا عروض بوربوينت ا أوراق عمل منهج انجليزي ا ملخصات وتقارير ا مذكرات وبنوك ا الامتحان النهائي ا للمدرس

التواصل الاجتماعي بحسب الصف السادس

صفحة المناهج الإماراتية على فيسبوك					
المواد على تلغرام	التربية الاسلامية	اللغة العربية	اللغة الانجليزية	الرياضيات	

المزيد من الملفات بحسب الصف السادس والمادة علوم في الفصل الأول

1	الهيكل الوزاري الجديد المسار العام منهج بريدج
2	أسئلة مراجعة نهائية منهج انسباير
3	تجميعة أسئلة وفق الهيكل الوزاري منهج انسباير
4	الهيكل الوزَاري الجديد المسار العام منهج انسباير (معدل)
5	اختبار القياس الدولي IBT متبوع بالإجابات

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Unit 3: Energy in the Atmosphere

Term 1 Final Exam
EOT Review

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Multiple Choice Questions

Compiled by: Ms Taybah Jaffar

Al Ma'ali School

1	Students will present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.	Engineering Connection	17

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.*

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Thermal expansion: As temperature increases, the particles have more kinetic energy and need more space to move, push each other further apart.

Thermal contraction: As temperature decreases, the particles have less kinetic energy, they collide less (push against each other less), need less space.

In a thermometer, when temperature increases, the liquid inside the thermometer expands and rises up the tube. When the temperature decreases, the liquid contracts and falls down the tube.

Multiple choice question examples:

1. What does temperature measure in a substance?

a. The color of the particles
b. The average speed of sound in the particles
c. The average kinetic energy of the particles
d. The total number of particles

2. How does a thermometer work as the temperature increases?

a. The liquid inside contracts
b. The liquid inside expands
c. The thermometer changes color
d. The thermometer makes a sound

3. Which of the following is NOT a correct statement about temperature?

a. Temperature is a measure of the average kinetic energy of particles
b. Temperature can be measured using a thermometer
c. Temperature is the same thing as heat
d. Temperature increases when the kinetic energy of particles increases

Answers:

1. c
2. B
3. c

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C. As with the metal ball and ring which were heated and cooled, the models of the particles would show particles that have less motion (and therefore less energy) in the metal block than in the wood block.

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.

Recall the video of the metal ball and ring. When the ball was heated it expanded and could not go through the ring. Through expansion the particles moved faster and have more energy.

If wood had to be heated, the particles would have less energy and move slower.

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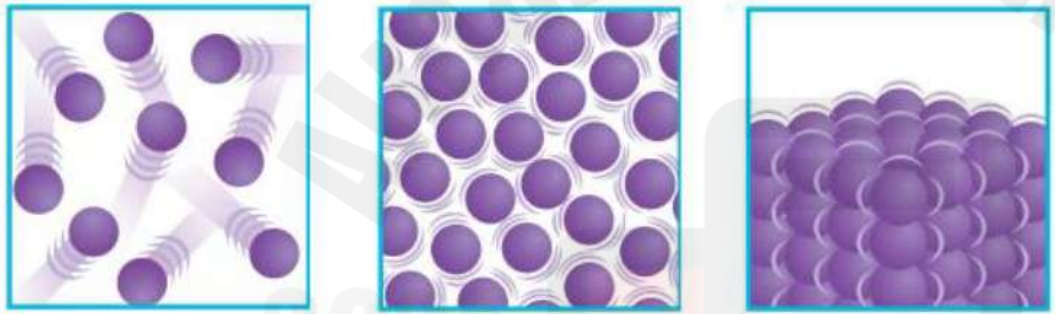

A **B** **C**

Identify the states of matter represented by letters **A**, **B**, and **C** in the image above.

A: Gas
(Many motion lines, large space between particles)

B: Liquid
(fewer motion lines, less space between particles)

C: Solid
(little space between particles, motion line very close together)

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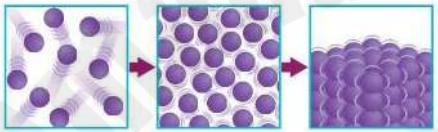
Examine the model below. The particles are undergoing a change in energy.



4. Which statement best describes what is taking place in the images?

   A The kinetic energy of the particles on the right is the greatest of the three images of particles.

   B The particles in the middle have more kinetic energy than the particles on the right.

   C The particles in the middle have less space between them than the particles on the left, which means they have more kinetic energy.

   D Energy was added to the particles on the left to give them more energy than the particles in the middle.

4.B (the middle is a liquid, right is a gas. Liquids have more energy than solids)

3	Students will plan and carry out investigations to understand factors, such as the nature of the matter that affect the amount of energy transfer.	Explain the Phenomenon	74
		Three-Dimensional Thinking	83

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EXPLAIN
THE PHENOMENON

Kitchenware is made of many different types of materials. Have you ever thought about how those different materials transfer thermal energy? Use your ideas about kitchenware to make a claim about what affects how a material transfers thermal energy.

Some materials, such as metals, conduct thermal energy easily. Other materials, such as wood or plastic, do not. The amount of energy needed to change the temperature of a material by a given amount depends on several factors.

How fast thermal energy transfers through a substance depends on 3 things

1. Type of matter
2. Mass of matter
3. Shape of matter

3	Students will plan and carry out investigations to understand factors, such as the nature of the matter that affect the amount of energy transfer.	Explain the Phenomenon	74
		Three-Dimensional Thinking	83

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Lesson 4: Thermal Energy Conductivity Important Information

Thermal energy moves from hot objects to cold objects. Thermal energy always within a system-open or closed and has a source and receiver object.

Thermal energy conductivity (how its moves between objects) depends of three things:

Use this for question 3 and 8 And long question 1

1. Mass

Mass means how many particles make up the substance/object.

Large mass = needs more thermal energy

Smaller mass = needs less thermal energy

Mass and thermal energy are **directly proportional**

Direct proportion

mass and temperature change are inversely proportional

Inverse proportion

2. Properties of Matter

1. Reflectivity

- Black objects absorb thermal energy
- White objects reflect thermal energy

2. Thin or Thick

- Thin objects heat up fast
- Thick objects heat up slower

3. Surface Area

- If an object has a lot of space to cover it with need more thermal energy.

3. Type of Material

All materials can transfer thermal energy.

But the rates will depend of the Specific Heat.

Specific Heat:

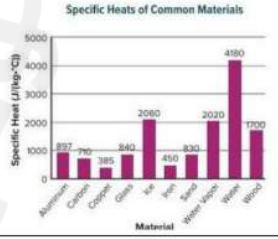
How long it takes an object to heat up and to cool down.

Scientific definition:

The quantity of heat required to raise the temperature of one gram of a substance by one Celsius degree

High S.H: needs lots of energy to heat up

Low S.H: needs less energy to heat up.



Conductors: allow lots of thermal energy to transfer

Insulators: allow little thermal energy to transfer

3	Students will plan and carry out investigations to understand factors, such as the nature of the matter that affect the amount of energy transfer.	Explain the Phenomenon	74
		Three-Dimensional Thinking	83

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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.

4	Students will determine the relationships among the energy transferred and the change in the average kinetic energy of the particles.	Lesson 1 Review (Summerize it!)	26
		Lesson 2 Launch (What's the Difference?)	29

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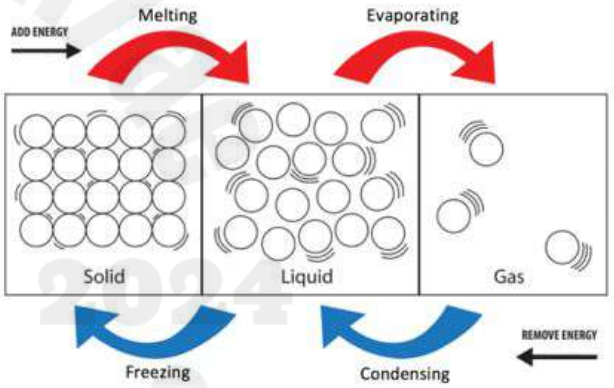
Summarize It!

1. **Relate** kinetic energy to the speed of particles.

No speed	no	kinetic energy
Greater mass	greater	kinetic energy
Greater speed	greater	kinetic energy

Model each statement above. Model the first statement as solid particles, the second statement as liquid particles, and the last statement as gas particles.

The first model should be a solid with no speed. There should not be any motion lines to indicate that the solid is in motion. The second model should be a liquid, and the particles should be farther apart than in the solid. There should be motion lines on the liquid particles to indicate that when more particles are present and moving, the more kinetic energy a substance has. The third model should be a gas with more motion lines than the liquid indicating that the gas particles are moving at a high speed.



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PAGE KEELEY SCIENCE PROBES

LESSON 2 LAUNCH

What's the Difference?

Five friends were talking about the differences among solids, liquids, and gases. They each agreed that the differences have to do with the particles in each type of matter. However, they disagreed about which differences determine whether the matter is a solid, liquid, or gas. This is what they said:

Gwyneth: I think it has to do with the number of particles.
George: I think it has to do with the shape of the particles.
Hoda: I think it has to do with the size of the particles.
Natalie: I think it has to do with the movement of the particles.
William: I think it has to do with how hard or soft the particles are.

With whom do you agree most? _____ Explain why you agree with that friend.

You will revisit your response to the Science Probe at the end of the lesson.

The best answer is Natalie: I think it has to do with the movement of the particles. The state of matter is determined by the motion of the matter's particles and the attractive forces between them. In a solid, particles vibrate in place, and the attractive forces keep the particles close together. In a liquid, particles move faster than they do in the solid state of that matter. The attractive forces between particles are not as strong as they are in the solid state of that matter. Particles move slightly farther apart and slide over one another. Yet they stay together, which explains why liquids have a definite volume but do not have a definite shape. In a gas, particles move faster and farther apart than in the solid and liquid states of that matter. The forces between particles are not strong enough to maintain an attraction between them. Particles can move away from each other, and this is why gases do not have a definite shape or definite volume.

The big idea is that states of matter are determined by the

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Solids	Liquids	Gases
In solids, tiny particles called molecules are packed closely together. They stay very close to each other. 	In liquids, the molecules are not as tightly packed as in solids. There is some space between them, which lets them move around a bit. 	In gases, the molecules are spread far apart from each other. There is a lot of empty space between them, so they can move around freely in any direction they want. 
Solids have a specific shape that doesn't change easily.	Liquids don't have a fixed or definite shape.	Gases don't have a fixed or specific shape.
They also have a specific amount of space they take up, which we call volume.	They do have a specific amount of space they occupy, which we call volume.	Gases don't have a fixed or specific volume.
Most solids are hard, meaning they are not easy to squish or bend.	Liquids can flow and move easily.	Gases can flow and move around freely.
When we move solids to a different container, they keep their shape.	When we put liquids in a container, they take the shape of that container.	Gases fill up all the available space inside a container and can be compressed easily.

Examples of MCQs

1. What determines the state of matter according to the text?

a. The color of the particles
b. The temperature of the environment
c. The motion of the particles and the attractive forces between them
d. The size of the particles

2. How do particles behave in a solid state?

a. Particles move freely and have no attraction
b. Particles vibrate in place and are close together
c. Particles move slightly apart and slide over each other
d. Particles break apart and form new substances

3. Why do liquids have a definite volume but no definite shape?

a. Particles are tightly packed and do not move
b. Particles move faster and are farther apart
c. Particles move faster and slide over each other, staying together

4. What happens to the particles in a gas state?

a. They vibrate in place and stay close
b. They move faster and stay tightly packed
c. They move faster and farther apart with weak attraction forces
d. They slide over each other and maintain a definite volume

5. Which statement is true about the attractive forces in liquids compared to solids?

a. Attractive forces in liquids are stronger than in solids
b. Attractive forces are the same in both states
c. Attractive forces in liquids are weaker than in solids
d. There are no attractive forces in liquids

1. c
2. b
3. c
4. c
5. c

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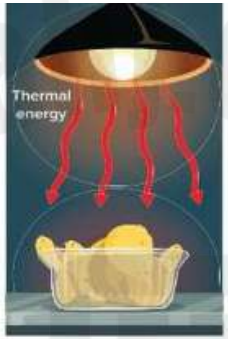
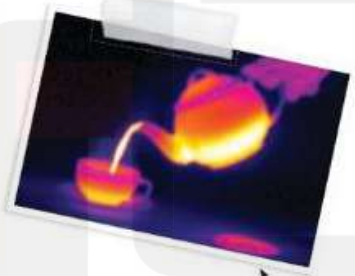
Radiation Another process that transfers energy is radiation. **Radiation** is the transfer of thermal energy from one material to another by electromagnetic waves. All matter, including the Sun, fire, and even you, transfers thermal energy by radiation. Warm objects emit more radiation than cold objects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



Conduction:
The teapot touched the table (two objects were touching)

Radiation:
The teapot, table and cup are all allowing thermal energy to move through the air (space)

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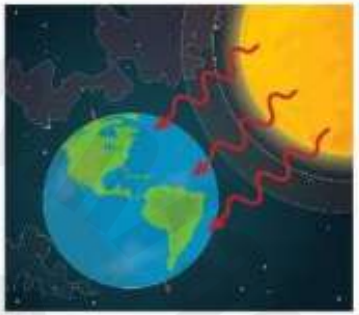
EARTH SCIENCE Connection Thermal energy from the Sun can only travel to Earth by radiation. This is because space is a vacuum—a space that contains little or no matter. Since there is little matter in space, thermal energy cannot transfer by conduction, which requires objects to be in contact. Radiation 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.

B. As we observed when we experimented using the lamp, radiation is the transfer of thermal energy by electromagnetic waves. These waves move outward from the hot toast in all directions.

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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.

Answer: D

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Real-World Connection

4. **Explain** Think of a time that you noticed a change of state. Explain what happened using the terms *temperature*, *particle motion*, and *energy*.

Student answers will vary. Sample answer: ice melts when it is taken out of the freezer because the temperature rises, which gives the particles more and more energy. Eventually the energy is enough to break the attractive forces between particles.

5. **Compare** the amount of thermal energy required to melt a solid with the amount of thermal energy released when the same liquid becomes a solid.

The amount of energy released would be the same amount required to melt the substance. This is why the melting point and the freezing point are at the same temperature.

6	Students will understand factors such as the nature of the matter and the size of the sample that affect the amount of energy transfer of a sample of matter.	Three-Dimensional Thinking	51
		Real-World Connection	52

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Multiple choice question example:

1. What happens to the particles of a solid when it is heated and begins to melt?
a. The particles move slower and lose energy.
b. The particles gain energy and move faster.
c. The particles stop moving completely.
d. The particles shrink in size.

2. Which term describes the energy needed to change a solid into a liquid?
a. Kinetic energy
b. Potential energy
c. Thermal energy
d. Chemical energy

3. What remains constant at the melting point of a substance while it changes state?
a. Temperature
b. Particle speed
c. Volume
d. Density

4. When a liquid freezes, what happens to the thermal energy?

a. It is absorbed by the substance.
b. It is released by the substance.
c. It remains unchanged.
d. It is converted into chemical energy.

5. Why do the melting point and freezing point of a substance occur at the same temperature?

a. Because the energy released is different from the energy absorbed.
b. Because the energy required to melt is the same as the energy released when freezing.
c. Because the particle motion is different in both processes.
d. Because they have different thermal properties.

1. b
2. c
3. a
4. b
5. b

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Three-Dimensional Thinking

Some students want to demonstrate thermal expansion. They devise the following method: A large black balloon is taken to a shady area and filled with cool air. The balloon is then taken to a bright, sunny location. After a short time, the balloon begins to expand.

3. What explanation does this investigation verify?
   - **A** A balloon filled with cool air will rise into the atmosphere.
   - **B** As particles gain energy, the material takes up more space.
   - **C** The air inside the balloon lost energy.
   - **D** The sunlight caused the air in the balloon to contract.

Examine the model below. The particles are undergoing a change in energy.

4. Which statement best describes what is taking place in the images?
   - **A** The kinetic energy of the particles on the right is the greatest of the three images of particles.
   - **B** The particles in the middle have more kinetic energy than the particles on the right.
   - **C** The particles in the middle have less space between them than the particles on the left, which means they have more kinetic energy.
   - **D** Energy was added to the particles on the left to give them more energy than the particles in the middle.

3.B (when particles gain energy, they need more space to move so the balloon expands)

4.B (the middle is a liquid, right is a gas. Liquids have more energy than solids)

8	Students will plan and carry out investigations to understand the nature of matter and the amount of energy transfer needed to change the temperature of a sample of matter.	Three-Dimensional Thinking	83	13
		Collect Evidence	83	14

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THREE-DIMENSIONAL THINKING

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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.

Some materials, such as metals, conduct thermal energy easily. Other materials, such as wood or plastic, do not. The amount of energy needed to change the temperature of a material by a given amount depends on several factors.

How fast thermal energy transfers through a substance depends on 3 things

1. Type of matter
2. Mass of matter
3. Shape of matter

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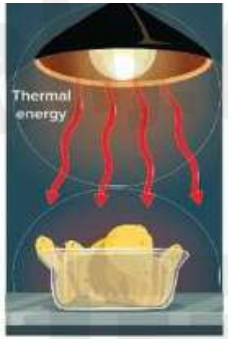

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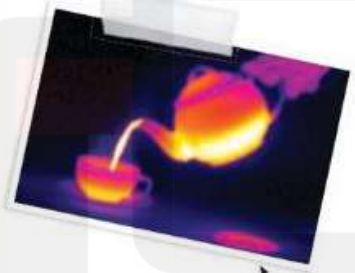

Radiation:

Transfer of thermal energy through electromagnetic waves (empty space).

Objects can be far away from each other.

Examples: sun warming earth
Sitting by the fire

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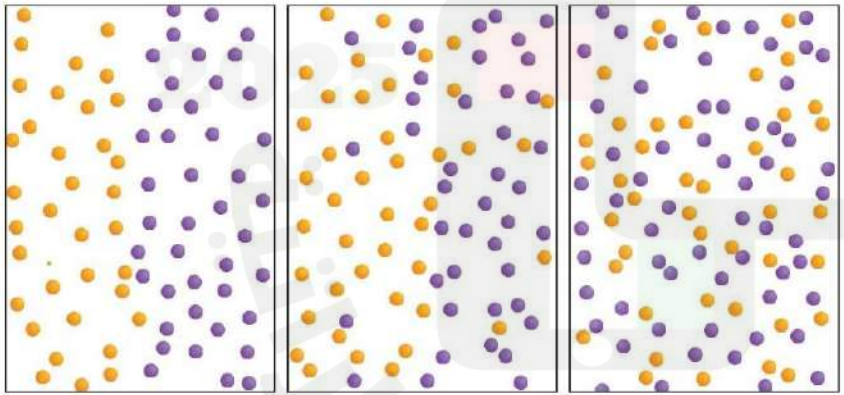
Movement and Collisions In the Lab *Wait For It*, the food coloring moved when the water in the beaker appeared to be completely still. How did this happen? Water particles, like the particles in all liquids, constantly bump and flow past each other in **random motion**—movement in all directions and 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.



Particles in matter are always bumping and flowing past each other.

This is called **random motion: movement of particles in all directions at different speeds.**

What process does the image represent?

Particles will always move from areas of high concentration to areas of low concentration. This is called Diffusion.

This means that particles move from where they are close together and then they spread out.

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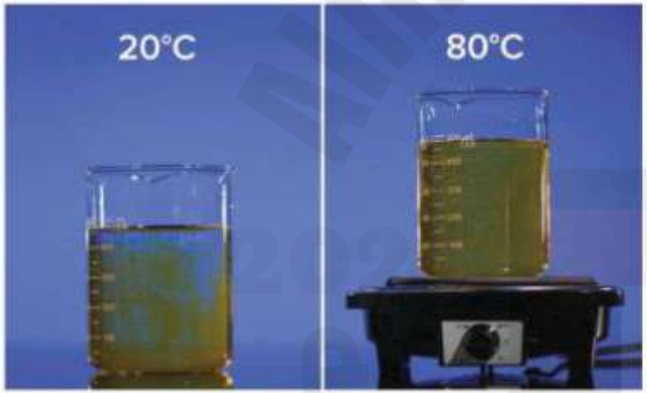
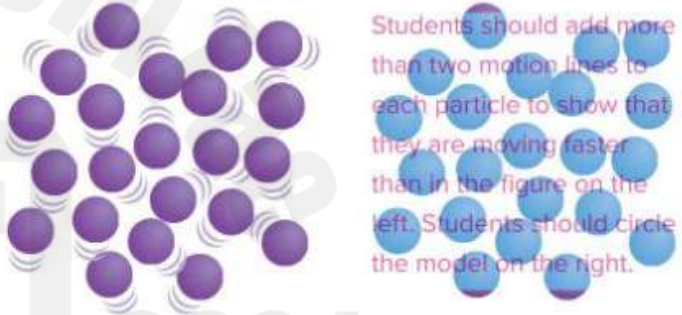
Movement and Energy Scientists use diffusion to observe how fast the particles of a substance are moving. The faster the substance diffuses, the faster the particles are moving. In the figure below, energy was added from the hot plate to the water and dye particles on the right. This added energy increased 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**.



We can use diffusion to understand how fast the particles move.

The faster the substance diffuses, the faster the particles are moving.

When we add heat energy, the particles move faster.

This means the particles have more **kinetic energy (movement energy).**

Multiple choice question examples:

1. What is the movement of particles in all directions at different speeds called?

a. Diffusion
b. Evaporation
c. Condensation
d. Random motion

2. When particles move from areas of high concentration to areas of low concentration, what is this process called?

a. Osmosis
b. Diffusion
c. Filtration
d. Combustion

3. What happens to particles when we add heat energy?

a. They stop moving
b. They move slower
c. They move faster
d. They disappear

4. Which of the following best describes diffusion?

a. Particles moving against the wind
b. Particles spreading out from high concentration to low concentration
c. Particles forming a solid
d. Particles staying in one place

5. What type of energy do particles have when they move faster?

a. Potential energy
b. Chemical energy
c. Kinetic energy
d. Solar energy

1. d
2. b
3. c
4. b
5. c

11	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch (What happened to the Puddle?)	103	18
		Three-Dimensional Thinking	111	19

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LESSON 1 LAUNCH

SCIENCE PROBES

What happened to the puddle?

Four friends noticed a large puddle on the sidewalk when they walked to school in the morning. When they walked home, the puddle was gone. They wondered what happened to the water that was in the puddle.

Desi: I think the water soaked into the bricks.
Trudi: I think the water went up into the clouds.
Max: I think the water is in the air around us.
Carli: I think the Sun changed it into something else.

Circle the student you most agree with. Explain why you agree with that student.

The best answer is Max: I think the water is in the air around us. When water evaporates, it goes into the air around us in a gaseous form we cannot see. Some of the Sun's radiant energy that reaches the puddle transfers to water molecules at the surface of the puddle. This enables them to be free of their attraction to other water molecules, move apart, and change into water vapor that enters into the atmosphere.

11	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch (What happened to the Puddle?)	103	18
		Three-Dimensional Thinking	111	19

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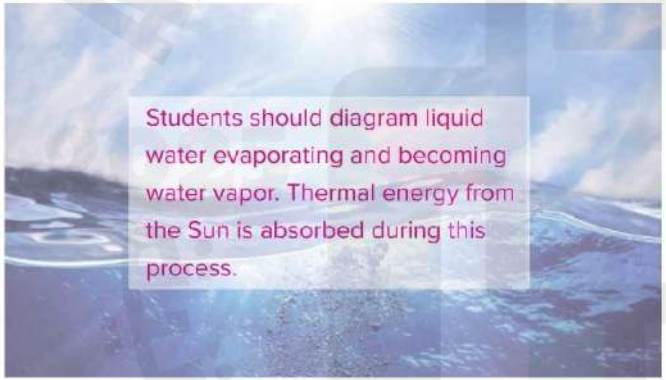
PHYSICAL SCIENCE Connection Water does not actually disappear from a puddle or a cloud. It evaporates. **Evaporation** is the process by which a liquid, such as water, changes into a gas. When the Sun shines on a body of water, water near the surface absorbs thermal energy and becomes warmer. As a molecule 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.

11	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch (What happened to the Puddle?)	103	18
		Three-Dimensional Thinking	111	19

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How does the thermal energy of the sun drive the water cycle?

1. **Evaporation:** Thermal energy causes the water on Earth to heat up and evaporate into the atmosphere. Water (liquid) changes to water vapor (gas).
2. **Condensation:** In the atmosphere the water vapor (gas) cools down because the temperature is colder and turns back into water droplets (liquid), the water droplets collect and form clouds.
3. **Cystalization:** When water droplets loose too much thermal energy in the atmosphere they can form ice crystals (solid)

11	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch (What happened to the Puddle?)	103	18
		Three-Dimensional Thinking	111	19

Multiple choice question examples:

1. What role does the sun play in the water cycle?

a. It prevents evaporation
b. It provides the energy necessary for evaporation
c. It causes water to freeze
d. It stops condensation

2. Which process in the water cycle is directly driven by the sun's heat?

a. Condensation
b. Precipitation
c. Evaporation
d. Crystallization

3. During which stage of the water cycle does water vapor cool and change into liquid droplets?

a. Evaporation
b. Condensation
c. Crystallization
d. Precipitation

11	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch (What happened to the Puddle?)	103	18
		Three-Dimensional Thinking	111	19

4. What happens during the crystallization stage of the water cycle?

a. Water turns into vapor
b. Water vapor forms clouds
c. Water changes into ice or snow
d. Water flows back into the ocean

5. Which of the following best describes condensation?

a. Liquid water changing to vapor
b. Water vapor changing into liquid droplets
c. Ice melting into water
d. Water flowing in rivers

1. b
2. c
3. b
4. c
5. b

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Albedo and Temperature The measure of the reflectivity of a surface is termed **albedo.** Light-colored, reflective surfaces like ice and thick cloud cover have a high albedo because these features reflect more sunlight. In contrast, dark surfaces such as soil or water in the absence of cloud cover have low albedo levels because they do not reflect much sunlight.

The temperature of the atmosphere is greatly affected by the albedo of the hydrosphere, geosphere, and biosphere. The more reflective a surface is, the less it absorbs solar energy.

Multiple choice question examples:

1. What is albedo?
a. The measure of the temperature of an object
b. The reflectivity of a surface
c. The amount of heat an object produces
d. The color of an object

2. How does a high albedo affect temperature?
a. It increases the temperature
b. It decreases the temperature
c. It has no effect on temperature
d. It makes the temperature fluctuate

3. Which surface would likely have a high albedo?
a. Dark soil
b. Forest
c. Snow-covered field
d. Ocean water

4. Why is albedo important in climate studies?

a. It helps scientists understand weather patterns
b. It affects the amount of sunlight Earth receives
c. It determines the color of the sky
d. It influences Earth's energy balance

5. What happens to the temperature if the Earth's albedo decreases?

a. The temperature might rise
b. The temperature might fall
c. The temperature will remain constant
d. The temperature will become unpredictable

1. b
2. b
3. c
4. d
5. a

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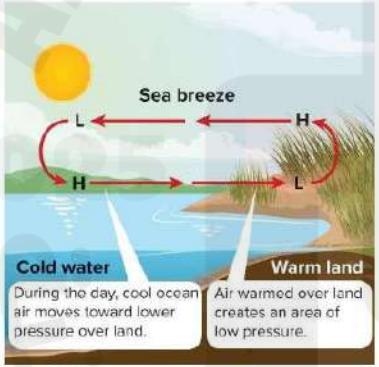
The Flow of Air You just discovered that differences in air pressure cause air to flow. **Wind** is the movement of air from areas of high pressure to areas of low pressure. The following activity explores two types of local winds—sea breezes and land breezes.

INVESTIGATION

It's a Breeze

GO ONLINE to watch the animation *Sea Breezes and Land Breezes*.

1. Using what you learned in the animation, model the formation of a land breeze in the space below.



Students' models should show wind blowing from the land to the sea. At night, the land cools more quickly than the water. Therefore, the air above the land cools more quickly than the air over the water. As a result, cool air over the land moves toward lower pressure over the water.

2. Predict whether a sea breeze could occur at night. Explain.

Sample answer: A sea breeze could only occur at night if the land stayed warmer than the water.

COLLECT EVIDENCE

What causes wind to blow? Record your evidence (A) in the chart at the beginning of the lesson.

Wind is caused by:

- Differences in air pressure
- Differences in air temperature

Convection current cause air to move as it warms and cools.

Direction of wind flow influenced by:

- Air pressure
- Coriolis effect
- Air temperature

Local winds:

13	Students will explore atmospheric and oceanic circulation.	Investigation	176	
		Collect Evidence	176	

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Multiple choice question examples

. What causes a sea breeze to occur during the day?

a. The land heats up faster than the sea, causing air to rise over the land.
b. The sea heats up faster than the land, causing air to rise over the sea.
c. The land and sea heat up at the same rate, causing air to move randomly.
d. The sea cools down faster than the land, causing air to rise over the sea.

2. How does a land breeze occur at night?

a. The sea heats up faster than the land, causing air to rise over the sea.
b. The land heats up faster than the sea, causing air to rise over the land.
c. The land cools down faster than the sea, causing air to move from land to sea.
d. The sea cools down faster than the land, causing air to move from sea to land.

3. What is the primary reason wind moves?

a. The rotation of the Earth.
b. The difference in air pressure between two locations.
c. The presence of mountains.
d. The movement of the sun.

13	Students will explore atmospheric and oceanic circulation.	Investigation	176	
		Collect Evidence	176	

4. Which direction does a sea breeze usually blow?

a. From the land to the sea.
b. From the sea to the land.
c. From the mountains to the sea.
d. From the sea to the mountains.

5. Why do areas near the coast often have milder temperatures?

a. The presence of mountains nearby.
b. The influence of ocean currents.
c. The continuous heating of the land.
d. The cooling effect of the desert.

1. a
2. c
3. b
4. b
5. b

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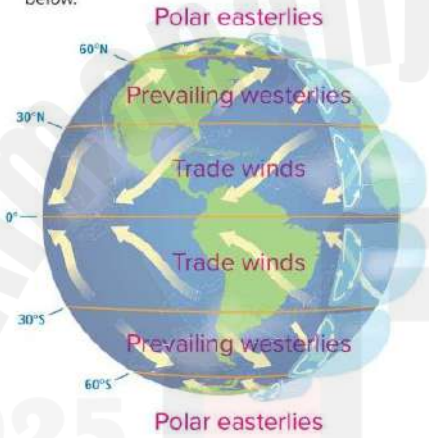
INVESTIGATION

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?

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COLLECT EVIDENCE

What are the global wind systems? Record your evidence (B) in the chart at the beginning of the lesson.

B. Answers may vary. Sample answer: In the *Rise and Fall, then Repeat* investigation, we discovered that Earth has large convection cells that redistribute thermal energy around the world. Air flows in these convection cells due to the uneven heating of Earth, which causes differences in air pressure. As seen in the Investigation *It's a Blowin'*, these convection cells help generate the polar easterlies, prevailing westerlies, and trade winds.

Global Winds:

Convection cells help to make three wind systems that move across each hemisphere.

This means hot air rises and cool air sinks in different patterns in different parts of each hemisphere.

There are three types of global winds:

1. Polar easterlies-blow from E to W near the poles (third convection cell)
2. Prevailing westerlies- blow from W-E between 30 N and 60 N and 30 S and 60 S.
3. Trade winds-blow from E-W between 30 N and 30 S. Wind blows towards the equator. (first convection cell)

Multiple choice question examples

1. What are global winds?

a. Winds that blow in a small area
b. Winds that blow steadily from specific directions over long distances
c. Winds that change direction frequently
d. Winds that are only found near the equator

2. Which winds are found near the poles and blow from east to west?

a. Trade Winds
b. Prevailing Westerlies
c. Polar Easterlies
d. Local Winds

3. What is the primary cause of the prevailing westerlies?

a. The rotation of the Earth
b. The Sun's gravity
c. Ocean currents
d. Mountains

14	Students will describe how rotation of Earth cause global patterns of winds and ocean currents.	Investigation	178	
		Collect Evidence	179	

4. Which winds are known for blowing from east to west in the tropics?

a. Polar Easterlies
b. Prevailing Westerlies
c. Trade Winds
d. Local Winds

5. How do convection cells contribute to global wind patterns?

a. They stop the movement of air
b. They create uneven heating of the Earth's surface
c. They cause air to circulate in large loops
d. They only affect the equator

1. b
2. c
3. a
4. c
5. c

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THREE-DIMENSIONAL THINKING

Imagine you are entering a large, air-conditioned building on a hot summer day. As you open the door, you feel cool air rushing past you out of the building. **Model** why you think this happens in the space below.

Students' models should indicate that the cool air in the building moves outside when the door is open because the air pressure is higher inside the building than outside. Astute students will make the connection that cooler air is more dense than warm air.

COLLECT EVIDENCE

How does the wind influence the movement of water? Record your evidence (D) in the chart at the beginning of the lesson.

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D. Answers may vary. Sample answer: As the Investigation *It's on the Surface* demonstrated, wind influences the movement of water by transferring energy to the water. Moving air particles drag on the water surface and cause the top part of the ocean to move. When wind pushes surface water, upwelling can occur as deeper and colder water moves vertically to the surface.

15	Students will explore atmospheric and oceanic circulation.	Three-Dimensional Thinking	175	
		Collect Evidence	186	

Multiple choice question examples

1. How does wind primarily influence water movement in the ocean?
a. By creating waves
b. By changing water temperature
c. By increasing salt concentration
d. By absorbing water vapor

2. What is the term for the movement of surface water caused by wind?
a. Evaporation
b. Erosion
c. Currents
d. Sedimentation

3. Which of the following is a result of wind blowing over the ocean's surface?
a. Formation of ice caps
b. Creation of surface currents
c. Decrease in ocean salinity
d. Increase in ocean depth

4. Why are some regions of the ocean more affected by wind than others?

a. Due to varying water temperatures
b. Because of differences in wind speed and direction
c. Due to the presence of marine life
d. Because of the amount of sunlight

5. What effect does wind have on the water cycle?

a. It slows down evaporation
b. It prevents precipitation
c. It helps in the process of evaporation
d. It stops condensation

1. a
2. c
3. b
4. b
5. c

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Writing Long Questions

Compiled by: Ms Taybah Jaffar

Al Ma'ali School

1	Students will determine the type of matter and the change in the average kinetic energy of the particles as measured by the temperature of the sample.	Movement and Energy, Three-Dimensional Thinking	14
	Students will determine the relationships among the energy transferred, the change in the average kinetic energy of the particles as measured by the temperature of the sample.	Summerize it!	26, 27
	Students will construct explanations of these relationships for a variety of substances.	Three-Dimensional Thinking	43

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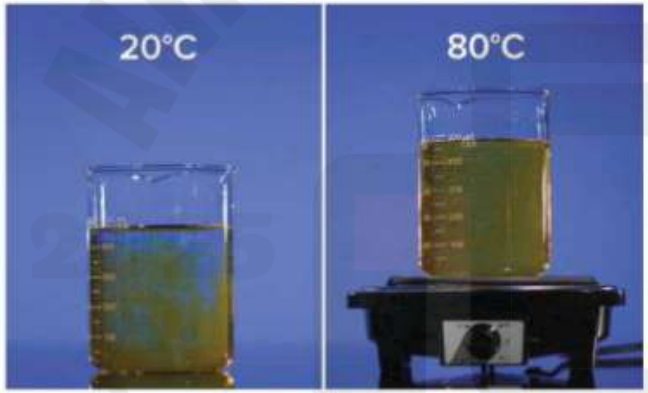
Movement and Energy Scientists use diffusion to observe how fast the particles of a substance are moving. The faster the substance diffuses, the faster the particles are moving. In the figure below, energy was added from the hot plate to the water and dye particles on the right. This added energy increased 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.

Adding more energy to the liquid on the right will cause the particles to moves fast and spread out more.

Adding energy increases the speed of the particles.

1	Students will determine the type of matter and the change in the average kinetic energy of the particles as measured by the temperature of the sample.	Movement and Energy, Three-Dimensional Thinking	14
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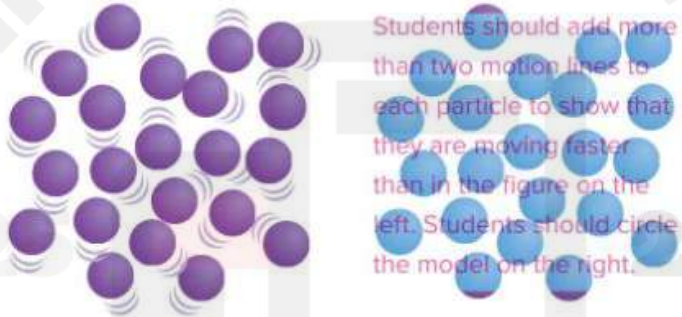
THREE-DIMENSIONAL THINKING

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**.



Students should add more than two motion lines to each particle to show that they are moving faster than in the figure on the left. Students should circle the model on the right.

1	Students will determine the type of matter and the change in the average kinetic energy of the particles as measured by the temperature of the sample.	Movement and Energy, Three-Dimensional Thinking	14
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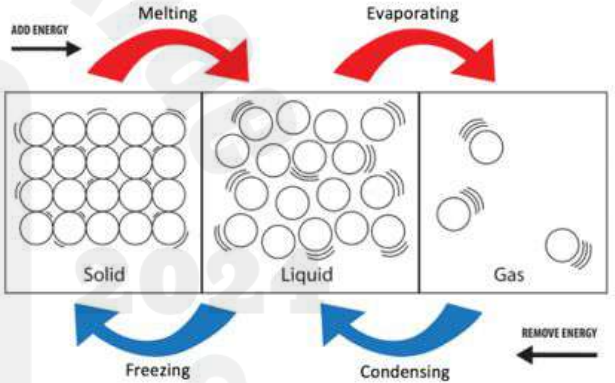
Summarize It!

1. **Relate** kinetic energy to the speed of particles.

No speed	→ no	kinetic energy
Greater mass	→ greater	kinetic energy
Greater speed	→ greater	kinetic energy



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Examine the model below. The particles are undergoing a change in energy.

4. Which statement best describes what is taking place in the images?

   A The kinetic energy of the particles on the right is the greatest of the three images of particles.

   B The particles in the middle have more kinetic energy than the particles on the right.

   C The particles in the middle have less space between them than the particles on the left, which means they have more kinetic energy.

   D Energy was added to the particles on the left to give them more energy than the particles in the middle.

4.B (the middle is a liquid, right is a gas. Liquids have more energy than solids)

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	Students will construct explanations of these relationships for a variety of substances.	Three-Dimensional Thinking	43

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).

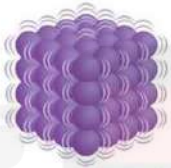
A

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

2	Students will explore how energy moves when objects are at different temperatures.	Lesson 3 Launch, Three-dimensional Thinking	53, 60, 65	
	Students will develop and use models to enhance their understanding of this process.	Lesson 4 Launch	71	
	Students will plan and carry out investigations to understand factors, such as the nature of the matter that affect the amount of energy transfer needed to change the temperature of a sample of matter.	Encounter the Phenomenon, Three-dimensional Thinking , Collect Evidence	73, 83, 89	

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LESSON 3 LAUNCH

PAGE KEELEY SCIENCE PROBES

Hot Soup

Janey had a bowl of hot soup for lunch. The soup was so hot she decided to put it in the refrigerator for a few minutes to cool it. What happened to cool the soup so Janey could eat it?

A. The heat moved from the soup to the cold air in the refrigerator.
B. The cold in the refrigerator moved into the hot soup.
C. No heat or cold moved out of or into the soup. It just cooled off.

Circle the answer that best matches your thinking. Explain your thinking. Describe what happened to cool the soup down.

The best answer is A. The heat moved from the soup to the cold air in the refrigerator. Heat involves the transfer of thermal energy. The big idea is that thermal energy moves from regions or objects of higher temperatures to regions or objects of lower temperatures. In this case the soup was at a higher temperature than the air inside the refrigerator. Thus, thermal energy moved from the soup to the air. Eventually the transfer of thermal energy would stop when both the soup and air reached the same temperature.

Remember:
Thermal energy moves from hot objects to cold objects.

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	Students will develop and use models to enhance their understanding of this process.	Lesson 4 Launch	71	
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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.

2	Students will explore how energy moves when objects are at different temperatures.	Lesson 3 Launch, Three-dimensional Thinking	53, 60, 65	
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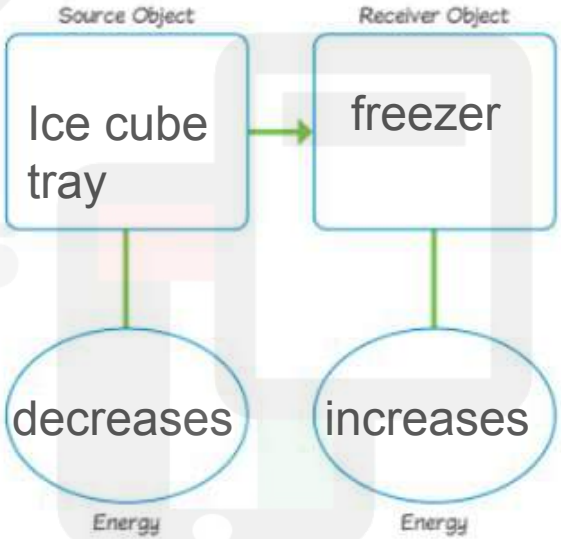
THREE-DIMENSIONAL THINKING

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.



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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?

2	Students will explore how energy moves when objects are at different temperatures.	Lesson 3 Launch, Three-dimensional Thinking	53, 60, 65	
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LESSON 4 LAUNCH

SCIENCE PROBES

Is the cup hot?

Adita and his friends were learning about insulators and conductors in school. They all agree that metal, a conductor, will heat up more quickly than ceramic, an insulator. They have different ideas about how the materials will cool. This is what each friend said:

Adita: I think the ceramic will cool quicker than the metal.
Niabi: I think the metal will cool quicker than the ceramic.
Irene: I think they will both cool at the same rate.
Rafi: I think conductors and insulators have nothing to do with how a material cools, just how a material heats up.

Which student do you agree with the most? _____
Explain your ideas about conductors and insulators.

The best answer is Niabi: I think the metal will cool quicker than the ceramic. Thermal energy transfers easily through conductors. The particles in a conductor move easily to collide with and pass along kinetic energy to neighboring particles. Thus, conductors are quick to heat up and quick to cool down.

2	Students will explore how energy moves when objects are at different temperatures.	Lesson 3 Launch, Three-dimensional Thinking	53, 60, 65	
	Students will develop and use models to enhance their understanding of this process.	Lesson 4 Launch	71	
	Students will plan and carry out investigations to understand factors, such as the nature of the matter that affect the amount of energy transfer needed to change the temperature of a sample of matter.	Encounter the Phenomenon, Three-dimensional Thinking , Collect Evidence	73, 83, 89	

ENCOUNTER THE PHENOMENON | Why is this kitchenware made out of so many different materials?

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The kitchen is where we make food so there is a lot of thermal energy transfers.

Utensils made of metals will transfer thermal energy more easily.

Utensils made of wood will transfer thermal energy less.

2	Students will explore how energy moves when objects are at different temperatures.	Lesson 3 Launch, Three-dimensional Thinking	53, 60, 65	
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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.

2	Students will explore how energy moves when objects are at different temperatures.	Lesson 3 Launch, Three-dimensional Thinking	53, 60, 65
	Students will develop and use models to enhance their understanding of this process.	Lesson 4 Launch	71
	Students will plan and carry out investigations to understand factors, such as the nature of the matter that affect the amount of energy transfer needed to change the temperature of a sample of matter.	Encounter the Phenomenon, Three-dimensional Thinking , Collect Evidence	73, 83, 89

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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.

Some materials, such as metals, conduct thermal energy easily. Other materials, such as wood or plastic, do not. The amount of energy needed to change the temperature of a material by a given amount depends on several factors.

How fast thermal energy transfers through a substance depends on 3 things

1. Type of matter
2. Mass of matter
3. Shape of matter

2	Students will explore how energy moves when objects are at different temperatures.	Lesson 3 Launch, Three-dimensional Thinking	53, 60, 65	
	Students will develop and use models to enhance their understanding of this process.	Lesson 4 Launch	71	
	Students will plan and carry out investigations to understand factors, such as the nature of the matter that affect the amount of energy transfer needed to change the temperature of a sample of matter.	Encounter the Phenomenon, Three-dimensional Thinking , Collect Evidence	73, 83, 89	

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4. The specific heat of air is 1.0 J/g•K and the specific heat of copper is 0.4 J/g•K. Which statement describes how each material would affect the amount of thermal energy transferred?

A Air and copper transfer thermal energy the same.

B Copper transfers thermal energy the quickest.

C Air transfers thermal energy the quickest.

D Specific heat does not determine how thermal energy transfers.

4. B—Correct. A and C are incorrect because copper has a lower specific heat, so it transfers thermal energy faster than air. D is incorrect because specific heat is the amount of thermal energy required to increase the temperature of 1 kg of a material by 1°C.

Specific Heat:

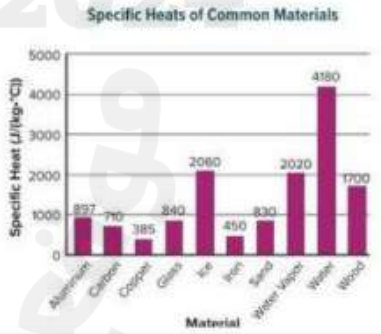
How long it takes an object to heat up and to cool down.

Scientific definition:

The quantity of heat required to raise the temperature of one gram of a substance by one Celsius degree

High S.H: needs lots of energy to heat up

Low S.H: needs less energy to heat up.



3	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch, Collect Evidence, Three-Dimensional Thinking,	103, 111, 112, 113, 116
	Students will explore the motion and cycling of water among Earth's subsystems.	Three-dimensional Thinking, Collect Evidence, Three-dimensional Thinking.	116, 118,
	Students will recognize various water reservoirs.	Lesson 2 Launch, Encounter the Phenomenon and Collect Evidence	121, 123,
	Students will explore the role of gravity in moving water downhill.	Three-dimensional Thinking, Lesson 2 Review (Summarize it!), Three-dimensional Thinking	131, 134,

LESSON 1 LAUNCH

SCIENCE PROBES

What happened to the puddle?

Four friends noticed a large puddle on the sidewalk when they walked to school in the morning. When they walked home, the puddle was gone. They wondered what happened to the water that was in the puddle.

Desi: I think the water soaked into the bricks.
Trudi: I think the water went up into the clouds.
Max: I think the water is in the air around us.
Carli: I think the Sun changed it into something else.

Circle the student you most agree with. Explain why you agree with that student.

The best answer is Max: I think the water is in the air around us. When water evaporates, it goes into the air around us in a gaseous form we cannot see. Some of the Sun's radiant energy that reaches the puddle transfers to water molecules at the surface of the puddle. This enables them to be free of their attraction to other water molecules, move apart, and change into water vapor that enters into the atmosphere.

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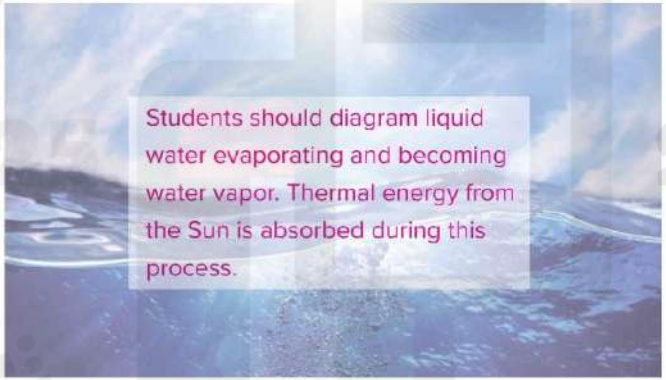
PHYSICAL SCIENCE Connection Water does not actually disappear from a puddle or a cloud. It evaporates. **Evaporation** is the process by which a liquid, such as water, changes into a gas. When the Sun shines on a body of water, water near the surface absorbs thermal energy and becomes warmer. As a molecule 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.

3	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch, Collect Evidence, Three-Dimensional Thinking,	103, 111, 112, 113, 116
	Students will explore the motion and cycling of water among Earth's subsystems.	Three-dimensional Thinking, Collect Evidence, Three-dimensional Thinking.	116, 118,
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COLLECT EVIDENCE

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

A. Answers may vary. Sample answer: In the Lab *Into Thin Air*, we saw that the Sun's energy causes liquid water to "disappear." When enough thermal energy is absorbed by water in clouds, they evaporate into invisible water vapor and the clouds "disappear."

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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.**

3	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch, Collect Evidence, Three-Dimensional Thinking,	103, 111, 112, 113, 116
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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.

3	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch, Collect Evidence, Three-Dimensional Thinking,	103, 111, 112, 113, 116
	Students will explore the motion and cycling of water among Earth's subsystems.	Three-dimensional Thinking, Collect Evidence, Three-dimensional Thinking.	116, 118,
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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.

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	Students will recognize various water reservoirs.	Lesson 2 Launch, Encounter the Phenomenon and Collect Evidence	121, 123,
	Students will explore the role of gravity in moving water downhill.	Three-dimensional Thinking, Lesson 2 Review (Summarize it!), Three-dimensional Thinking	131, 134,

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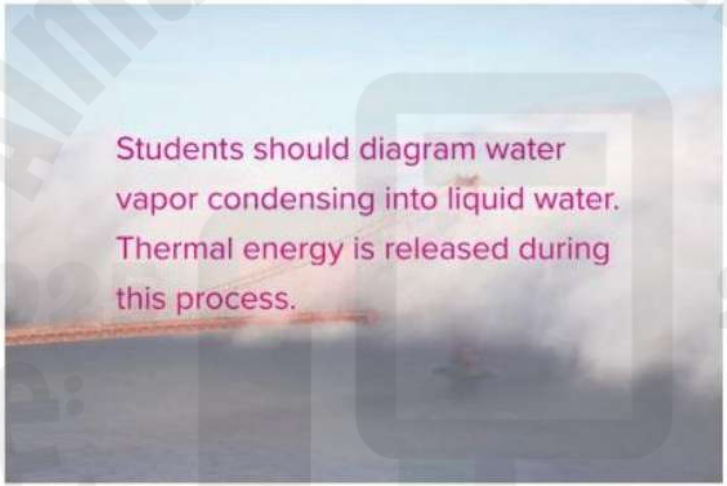
THREE-DIMENSIONAL THINKING

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.



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	Students will recognize various water reservoirs.	Lesson 2 Launch, Encounter the Phenomenon and Collect Evidence	121, 123,
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COLLECT EVIDENCE

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

C. Answers may vary. Sample answer: When water vapor in the atmosphere cools, it loses thermal energy and condenses into liquid water in a process called condensation. I modeled and observed this process in the Lab *Out of Thin Air*. Water droplets in the atmosphere block and reflect light making them visible as clouds. I read that crystallization can also cause clouds to appear.

3	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch, Collect Evidence, Three-Dimensional Thinking,	103, 111, 112, 113, 116
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Summarize It!

1. **Sketch** Create a concept sketch that models how water cycles into and through the atmosphere. To construct a concept sketch, begin by listing the processes and relationships you want to describe. Then, draw your sketch and write complete sentences describing the sketch. Include labels for the energy that drives water cycling, the state that water is in at each step (solid, liquid, or gas), and the transfer of thermal energy. Be creative!

Check students' concept sketches for accuracy.
Sketches should include evaporation, transpiration, respiration, condensation, and crystallization. The Sun should be labeled as the source of thermal energy that drives the cycling of water. Water is in solid form after undergoing crystallization, liquid form after condensation, and is a gas after undergoing the processes of evaporation, transpiration, and respiration.
Thermal energy is absorbed during evaporation and released during condensation and crystallization.

3	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch, Collect Evidence, Three-Dimensional Thinking,	103, 111, 112, 113, 116
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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

Answer: D

3	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch, Collect Evidence, Three-Dimensional Thinking,	103, 111, 112, 113, 116
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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.

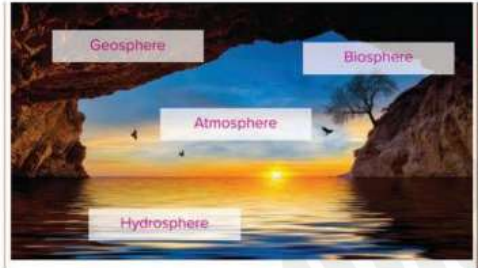
   B When water changes state from a solid to a liquid, thermal energy is absorbed.

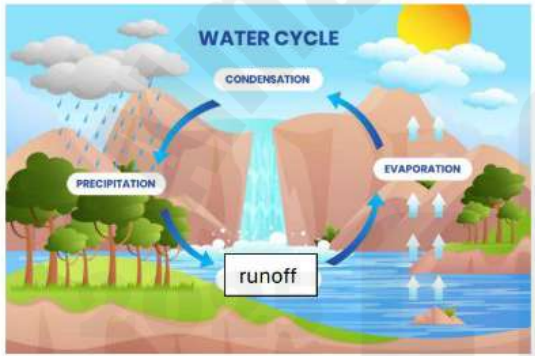
   C When water changes state from a liquid to a solid, thermal energy is released.

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

Answer: C

Spheres of the Earth





1. **Evaporation** (Sun heat causes water on Earth to get hot and turn into water vapor)
2. **Condensation** (The water in the atmosphere starts to cool down in the clouds)
3. **Precipitation** (clouds start to fill with water, comes back to Earth's surface in rain, snow, hail or sleet)
4. **Runoff** (water joins rivers, oceans)

Other ways water enters the atmosphere:

1. Transpiration: plants release water vapor into the atmosphere through the openings of the stomata.
2. Cellular Respiration: food molecules are broken down and carbon dioxide and water are released as waste.
3. Decomposition: when plants and animals die, their bodies decompose and water is released.

How does water "reapper"

Temperatures in the atmosphere become coller as water vapor rises higher.

It looses thermal energy .

When water vapor looses too much thermal energy, the liquid changes to a solid. This is called **Crystallization.**

Remember:

Thermal energy and Gravity is the what makes the water cycle work.

When water turns from liquid to solid, thermal energy is released.

When water turns from solid to liquid, thermal energy is

3	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch, Collect Evidence, Three-Dimensional Thinking,	103, 111, 112, 113, 116	40, 41, 42, 43, 44, 45
	Students will explore the motion and cycling of water among Earth's subsystems.	Three-dimensional Thinking, Collect Evidence, Three-dimensional Thinking.	116, 118, 119	46, 47, 48, 49
	Students will recognize various water reservoirs.	Lesson 2 Launch, Encounter the Phenomenon and Collect Evidence	121, 123, 129	50, 51, 52
	Students will explore the role of gravity in moving water downhill.	Three-dimensional Thinking, Lesson 2 Review (Summarize it!), Three-dimensional Thinking	131, 134, 135	53, 54, 55

PAGE KEELEY SCIENCE PROBES

LESSON 2 LAUNCH

Groundwater

Jane was drinking a glass of water. She asked her father where the water came from. Her father said it was groundwater that was pumped up by their well. Jane wondered what the water looked like underground. This is what her family said:

Mom: I think it looks like a huge ocean underground.
Dad: I think it looks like a small lake underground.
Jack: I think it seeps into little holes or spaces between the soil and the rocks.
Annie: I think it looks like a long, underground tube filled with water.
Philip: I think it looks like an underground volcano with water spurting out of the top.

Which person do you agree with the most? Explain your ideas about groundwater.

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The best answer is Jack: I think it seeps into little holes or spaces between the soil and the rocks. Groundwater is water that falls to Earth through precipitation and soaks down into the ground. It fills in the tiny spaces or pores between soil and rock underground. Sometimes it is close to the surface and other times it is deep underground. The big idea is that groundwater is an important source of freshwater that differs from other bodies of water in the way it forms.

3	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch, Collect Evidence, Three-Dimensional Thinking,	103, 111, 112, 113, 116	40, 41, 42, 43, 44, 45
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	Students will recognize various water reservoirs.	Lesson 2 Launch, Encounter the Phenomenon and Collect Evidence	121, 123, 129	50, 51, 52
	Students will explore the role of gravity in moving water downhill.	Three-dimensional Thinking, Lesson 2 Review (Summarize it!), Three-dimensional Thinking	131, 134, 135	53, 54, 55

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ENCOUNTER THE PHENOMENON

How might a single drop of water travel from a cloud to a stream to an aquifer?

Water falls to Earth's surface as precipitation in the form of rain, snow, sleet, or hail. The water can enter the ocean or other bodies of water, or seep into the ground to become groundwater.

3	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch, Collect Evidence, Three-Dimensional Thinking,	103, 111, 112, 113, 116	40, 41, 42, 43, 44, 45
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COLLECT EVIDENCE

Why does water on Earth's surface flow and where does it go?
Record your evidence (B) in the chart at the beginning of the lesson.

B. Answers may vary. Sample answer: In the *Streaming* By investigation, I collected evidence that gravity pulls water downhill on Earth's surface in streams and also down into the ground as groundwater. Water flows into and out of streams via precipitation and groundwater flow. Eventually it enters the ocean.

3	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch, Collect Evidence, Three-Dimensional Thinking,	103, 111, 112, 113, 116	40, 41, 42, 43, 44, 45
	Students will explore the motion and cycling of water among Earth's subsystems.	Three-dimensional Thinking, Collect Evidence, Three-dimensional Thinking.	116, 118, 119	46, 47, 48, 49
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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?

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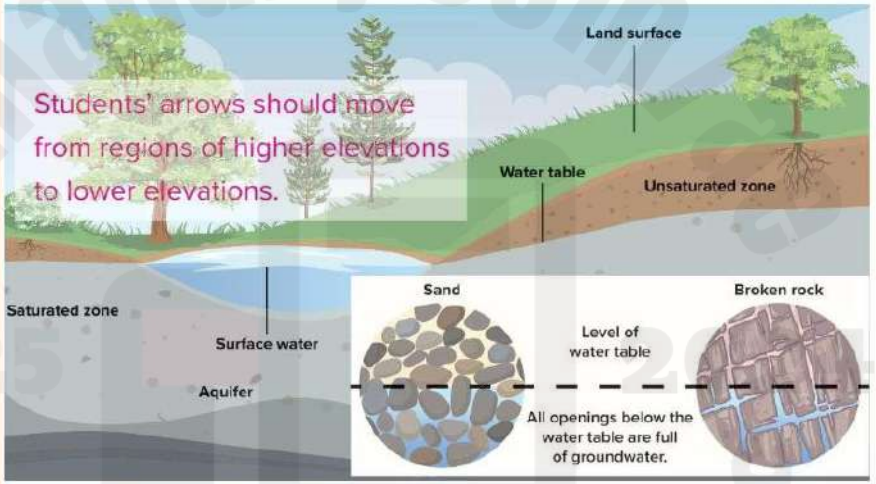
THREE-DIMENSIONAL THINKING

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.

3	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch, Collect Evidence, Three-Dimensional Thinking,	103, 111, 112, 113, 116	40, 41, 42, 43, 44, 45
	Students will explore the motion and cycling of water among Earth's subsystems.	Three-dimensional Thinking, Collect Evidence, Three-dimensional Thinking.	116, 118, 119	46, 47, 48, 49
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Summarize It!

1. **Organize** Create a graphic organizer that illustrates the role of gravity in keeping water moving on Earth. Include at least four places where water is stored and the state that water is in at each reservoir.

Gravity
(force pulling things down to earth)

Precipitation:
Rain, hail, sleet or snow (different states of water liquid or solid) is pulled down by gravity.

Runoff:
Gravity allows water to move down towards the reservoirs for storage in the oceans, rivers, glaciers or underground

3	Students will explore how the transfer of thermal energy drives processes of the water cycle, including evaporation, condensation, and crystallization.	Lesson 1 Launch, Collect Evidence, Three-Dimensional Thinking,	103, 111, 112, 113, 116	40, 41, 42, 43, 44, 45
	Students will explore the motion and cycling of water among Earth's subsystems.	Three-dimensional Thinking, Collect Evidence, Three-dimensional Thinking.	116, 118, 119	46, 47, 48, 49
	Students will recognize various water reservoirs.	Lesson 2 Launch, Encounter the Phenomenon and Collect Evidence	121, 123, 129	50, 51, 52
	Students will explore the role of gravity in moving water downhill.	Three-dimensional Thinking, Lesson 2 Review (Summarize it!), Three-dimensional Thinking	131, 134, 135	53, 54, 55

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Three-Dimensional Thinking

Four friends are walking along the bank of a stream. They each have differing opinions of why the stream moves along Earth's surface.

2. Which person do you agree with the most?
   - **A** Marco: Wind drags water particles along in the stream.
   - **B** Selma: Gravity causes water in the stream to move downhill.
   - **C** Brock: The Sun warms the stream causing it to flow.
   - **D** Chen: The stream moves because of its velocity.

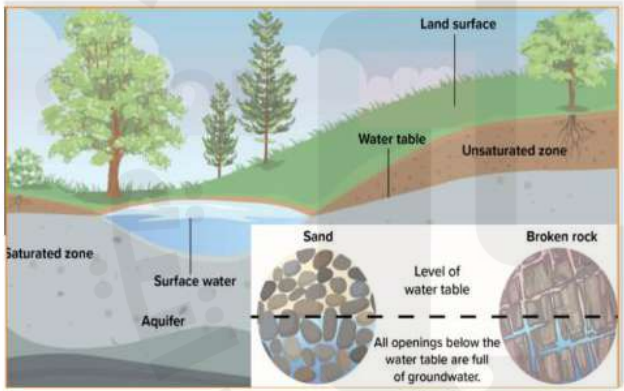
Answer: B

Remember the force of gravity pulls everything down

Precipitation

- Energy from the sun causes water on Earth's surface to evaporate into the atmosphere.
- The temperature in the atmosphere is lower so it causes the water vapor to condense.
- Once the water vapor condenses or cystalizes it will form a cloud.
- The liquid that falls is called precipitation.

The 4 types of precipitation are: rain, hail, sleet and snow



Where is water stored?

1. **Aquifers:** Groundwater trapped below earth's surface.
2. **Reservoirs:** Water storage like:
   Oceans, Seas, Lakes, Ice caps and Ground water
3. Permeable layers: Water collects in tiny holes within rocks and move deep underground to aquifers.
4. **Water Springs:** Extra water from aquifer can't go further underground so it pushes back up to the surface of Earth.
5. **Water Wells:** Humans dig up water from deep underground.
6. **Water in the desert:** Water comes from underground aquifer.
   Too much water rises to surface and makes an oasis in the desert.

Remember: Gravity pulls down the water.

4	Students will investigate the transfer of energy from the Sun to Earth and the atmosphere.	Lesson 1 Launch, Encounter the Phenomenon, and Three-Dimensional Thinking	145, 147, 151
	Students will use models to describe the unequal heating of Earth by the Sun and how energy flows through the system of Earth and the atmosphere.	Three-dimensional Thinking, Lesson 1 Review (Summerize it!)	159, 164, 166
	Students will explore atmospheric and oceanic circulation.	Investigation	176
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LESSON 1 LAUNCH

PROBES

What a difference!

Four friends are at the beach on a sunny day. They notice that the sand is much warmer than the ocean water. They wondered why the temperatures of these surfaces differed even though they are exposed to the same amount of sunlight.

Carla: I think that land warms faster than the ocean because water requires more energy to be heated.

Ethan: I think the land warms faster than the ocean because solar energy is more attracted to solid surfaces than liquid surfaces.

Max: I think the land warms faster than the ocean because water is clear and sunlight can pass through it more easily than the land.

Talia: I think the land warms faster than the ocean because water depth increases away from the shore.

Circle the name of the friend you most agree with. Explain why you agree with that friend.

The best answer is Carla: I think that land warms faster than the ocean because water requires more energy to be heated.

The big idea is that land and water absorb and release energy from the Sun at different rates. Water absorbs and releases thermal energy more slowly than land because water has a higher specific heat. That means ocean water requires more thermal energy to raise its temperature than land does. Students who choose Ethan may be influenced by the misconception that energy, like a magnet, is attracted to some materials more than others. Students who choose Max may confuse ocean water's translucency with its ability to reflect or absorb light and thermal energy. Students who choose Talia may have experienced ocean water depth increasing with distance from the shore, and may believe that this phenomenon is related to water's slower rate of warming.

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ENCOUNTER THE PHENOMENON | What effect does the Sun have on water?

Energy transfers from the Sun to Earth by radiation and to the atmosphere by radiation and conduction. Through this energy transfer, the Sun's energy warms different parts of Earth.

Remember:

1. Water has a high specific heat, it takes a long time to get hot, and a long time to get cold.
2. Some objects will absorb the heat of the sun (black objects) so containers that are dark the water temperature will rise more.
3. Some objects reflects the heat of the sun (white/light objects) so containers that are light the water temperature will not rise too much.

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Two containers, one black and one white, were filled with room temperature water. A lid, the same color as its respective container, was placed on top. Both containers were placed in the Sun. The water temperature of each container was measured after 20 minutes.

Analyze the data that resulted as each container was exposed to the Sun.

Water Temperature	Black Container	White Container
Temperature before sunlight exposure	25°C	25°C
Temperature after sunlight exposure	32°C	28°C

What reasoning can you provide that energy from the Sun reached the containers?

Sample answer: The temperature of both containers increased.

Why do you think the containers were different temperatures after exposure to the sunlight?

Sample answer: The color of the containers affected the amount of energy absorbed from the Sun.

GO ONLINE
Watch the video *Crepuscular Rays* to see this phenomenon in action.

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THREE-DIMENSIONAL THINKING

Models can be used to represent systems and their interactions. How did this demonstration model energy transfer between the Sun and Earth? Support your reasoning with a real-life example.

Energy from the sun is transferred to Earth.
DIfferent areas of Earth receive different amounts of this energy.
Some areas receive more and others less.

The sun is able to transfer enough energy to melt snow and ice on Earth's surface.

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THREE-DIMENSIONAL THINKING

You just investigated how thermal energy from land and water influence the atmosphere. Now, use these **cause-and-effect** relationships to predict how land, water, and air will absorb and release thermal energy in the following scenarios.

1. Suppose you go to the beach in the morning of a sunny summer day. **Explain** the rate at which thermal **energy** is absorbed by the water, sand, and air during the day.

Sample answer: The sand will absorb thermal energy at a faster rate than the water. The air above the land will absorb thermal energy at a faster rate than the air above the water.

4	Students will investigate the transfer of energy from the Sun to Earth and the atmosphere.	Lesson 1 Launch, Encounter the Phenomenon, and Three-Dimensional Thinking	145, 147, 151
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2. **Explain** why the flow of **energy** between air and sand is different than that between air and water as thermal energy is absorbed from day to night.

Sample answer: Water has a higher specific heat than land. Air has a lower specific heat compared to land and water. Therefore, energy is absorbed at a faster rate between land and air than between water and air. Land and water highly influence the temperature of air.

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3. As the Sun begins to set, predict the effect on the rate at which the air, water, and sand will cool.

Sample answer: The sand will release thermal energy at a faster rate than the water. The air above the land will release thermal energy at a faster rate than the air above the water.

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THREE-DIMENSIONAL THINKING

For Earth to radiate thermal energy, it must first absorb thermal energy. However, some natural surfaces on Earth and in the atmosphere are more reflective than absorbent. Examine the photo below.

Use the photo to describe areas of high and low albedo. **Explain** your reasoning.

Sample answer: The snow peaked mountain tops have a high albedo compared to the darker mountain rocks. This is because lighter colored objects are more reflective than darker colored objects.

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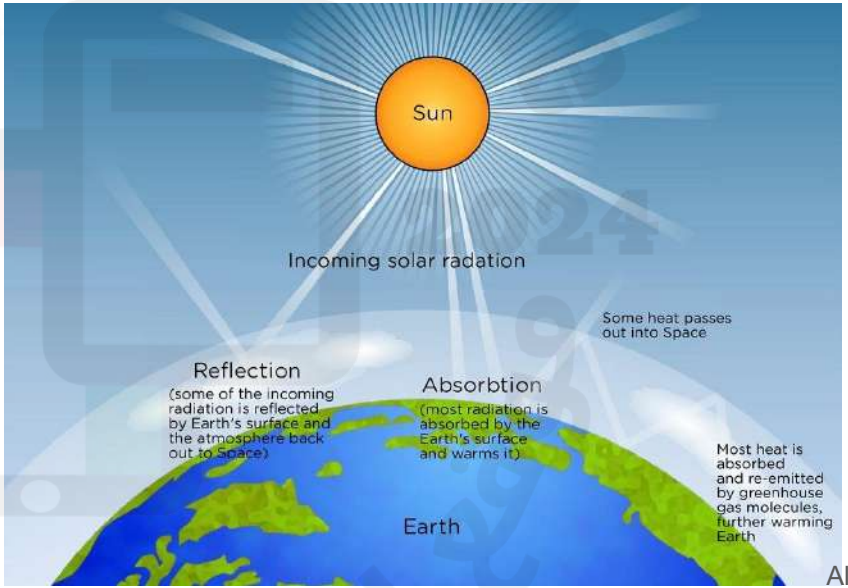
Summarize It!

1. **Diagram** Create a visual to show how energy is transferred from the Sun to Earth and the atmosphere. Include how features on Earth's surface affect this transfer of energy.



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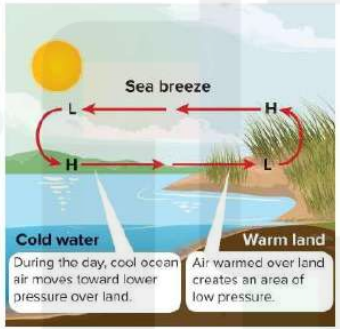
The Flow of Air You just discovered that differences in air pressure cause air to flow. **Wind** is the movement of air from areas of high pressure to areas of low pressure. The following activity explores two types of local winds—sea breezes and land breezes.

INVESTIGATION

It's a Breeze

GO ONLINE to watch the animation *Sea Breezes and Land Breezes*.

1. Using what you learned in the animation, model the formation of a land breeze in the space below.



Students' models should show wind blowing from the land to the sea. At night, the land cools more quickly than the water. Therefore, the air above the land cools more quickly than the air over the water. As a result, cool air over the land moves toward lower pressure over the water.

2. Predict whether a sea breeze could occur at night. Explain.

Sample answer: A sea breeze could only occur at night if the land stayed warmer than the water.

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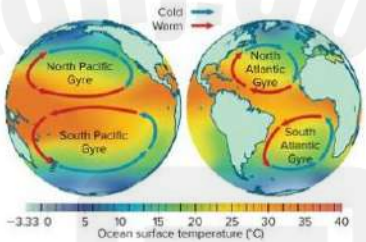
THREE-DIMENSIONAL THINKING

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.

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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.

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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.