شرح درس الجسيمات في حالة حركة – الوحدة الأولى من منهج انسباير

تم تحميل هذا الملف من موقع المناهج الإماراتية
موقع المناهج ⇦ المناهج الإماراتية ⇦ الصف السادس ⇦ علوم ⇦ الفصل الأول ⇦ ملفات متنوعة ⇦ الملف
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2	مذكرة مراجعة هيكل الاختبار النهائي مع الحل (محلول)
3	مذكرة هيكل مراجعة واختبار نهائي بدون حل (غير محلول)
4	حل تجميع للهيكل مطابق لوصف الهيكل 2027 - منهج عربي
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MINISTRY OF EDUCATION

End of Term 1 Exam Coverage

Grade 6 General – Science

Academic Year 2026-2027

Inspire

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Q1 : Module 1: Energy and Matter

Lesson 1: Particles in Motion

Identify particles in solids, liquids and gases.

(Pages 19 - 21)

Multiple Choice Questions - MCQ

Structured Concept Explanation (How do Particles in a Gas behave compared to particles in a solid? · Page 19-21):

Particles in all states of matter are in constant random motion, which means they have kinetic energy. In a gas, particles are very far apart compared to their size, have the most kinetic energy, and move at high speeds in straight lines until they collide with another particle or a wall and change speed and direction. Because of the large spaces between particles, gases can easily expand and contract to fill any container. In a liquid, particles are closer together and randomly flow and bump past one another. In a solid, particles are tightly packed and vibrate back and forth in place without flowing past each other, giving solids the least kinetic energy and a definite shape.

Key Ideas from the Student Book:

- Random motion: Particles move in all directions and at different speeds unless they collide.
- Gas expansion & compression: Gases have no fixed shape or volume; they spread out to fill a container (like pizza aroma in a room).
- Solid rigidity: Solid particles are held tightly in place and only vibrate back and forth, so a solid is not a fluid.

State of Matter	Particle Spacing	Particle Motion	Kinetic Energy
Gas	Very far apart (much larger than particle size)	Move rapidly in straight lines; collide and change speed/direction	Highest kinetic energy
Liquid	Close together with small spaces	Move randomly; slide and bump past each other (fluid)	Moderate kinetic energy
Solid	Tightly packed in fixed positions	Vibrate back and forth in place; cannot flow	Lowest kinetic energy

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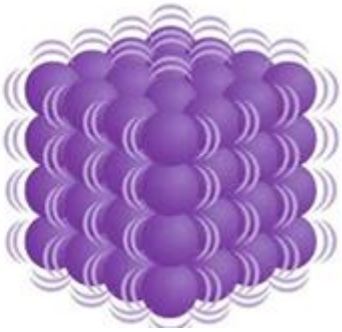
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Remember:

✓ Gas particles = far apart + move in straight lines at high speeds + highest kinetic energy.

✓ Solid particles = tightly packed + vibrate in place + lowest kinetic energy.

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.



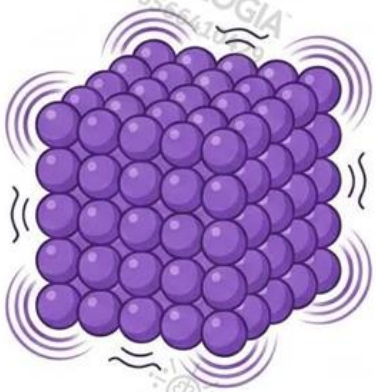
COLLECT EVIDENCE

How 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.

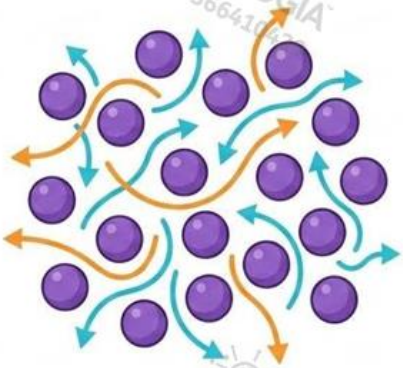
Freedom of Movement: Solids vs. Liquids

Solid Particles



- Locked in place in a rigid structure.
- Do not have the freedom to move around.
- Have low kinetic energy and only vibrate back and forth.

Liquid Particles



- Unlocked and unorganized.
- Have more kinetic energy than solids.
- Constantly bump and flow past each other in random motion.

Questions :

Question 1: In the graphic organizer above, what happened to the gas particles inside the balloon when the balloon was cooled, and when it returned to room temperature?

(A) When cooled, kinetic energy decreased and gas particles moved slower and closer together (thermal contraction); at room temperature, kinetic energy increased and gas particles moved faster and farther apart (thermal expansion).	(B) When cooled, kinetic energy increased and gas particles moved faster; at room temperature, kinetic energy decreased and gas particles froze in place.
(C) In both cases, the gas particles stayed locked in a fixed crystal pattern without changing volume.	(D) The number of gas particles inside the sealed balloon doubled when heated.

Question 2: When the metal ball was heated, it could not fit through the metal ring. How do you model and explain the particles in the solid metal ball when heated and cooled?

(A) Solid particles are tightly packed and vibrate in fixed positions; heating increased kinetic energy so they vibrated faster and moved slightly farther apart (thermal expansion), while cooling decreased kinetic energy so they moved closer together (thermal contraction).	(B) Solid particles flew far apart like a gas when heated and turned into a liquid when cooled.
(C) Heating caused the solid particles to grow larger in size and double their mass.	(D) Solid particles do not move or vibrate at any temperature.

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Question 3: How do particles in a gas behave compared to particles in a solid?

(A) Gas particles vibrate in fixed positions, while solid particles move rapidly in straight lines.	(B) Gas particles are far apart and move rapidly in straight lines, while solid particles vibrate in place.
(C) Both gas and solid particles flow freely past one another at the same speed.	(D) Gas particles have the least kinetic energy, while solid particles have the most kinetic energy.

Question 4: In which state of matter do particles have the MOST kinetic energy?

(A) Solid	(B) Liquid
(C) Gas	(D) Crystalline solid

Question 5: In which state of matter do particles have the LEAST kinetic energy?

(A) Solid	(B) Liquid
(C) Gas	(D) Water vapor

Question 6: How do gas particles move between collisions?

(A) In circular orbits around a fixed center	(B) In a straight line at high speeds
(C) By vibrating only in one fixed spot	(D) They remain completely still

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Question 7: What happens when two gas particles collide with each other?

(A) They stop moving permanently	(B) They freeze into a solid crystal
(C) They lose all of their mass	(D) They change both speed and direction

Question 8: Why are you able to smell a hot pizza from across a room?

(A) Gas particles from the pizza move rapidly and spread out through the air	(B) Solid particles from the crust float across the room
(C) Air particles stop moving when heated	(D) Gravity pulls the smell upward only

Question 9: How is the motion of particles in a solid best described?

(A) They fly freely in straight lines across the room	(B) They flow and slide easily over one another
(C) They vibrate back and forth in place	(D) They do not move at all

Question 10: Why can a gas easily expand or be compressed into a smaller volume?

(A) Gas particles can shrink in size	(B) There are very large empty spaces between gas particles
(C) Gas particles are tightly locked together	(D) Gas particles have no kinetic energy

Question 11: Which states of matter are classified as fluids because their particles can flow past one another?

(A) Solids only	(B) Solids and liquids
(C) Solids and gases	(D) Liquids and gases

Question 12: Why is a solid NOT considered a fluid?

(A) Its particles vibrate in fixed positions and cannot flow past each other	(B) Its particles move too fast in straight lines
(C) Its particles have no mass	(D) Its particles are too far apart to touch

Question 13: What does "random motion" of particles mean?

(A) Particles move only from north to south at one fixed speed	(B) Particles move only when stirred with a spoon
(C) Particles move in all directions and at different speeds	(D) Particles move only downward due to gravity

Question 14: How do particles in a liquid behave compared to particles in a solid?

(A) Liquid particles are locked in place, while solid particles flow freely	(B) Liquid particles slide and bump past each other, while solid particles vibrate in place
(C) Liquid particles have less kinetic energy than solid particles	(D) Liquid particles never touch or collide with each other

Question 15: What keeps a balloon inflated when filled with air?

(A) Solid particles freezing on the rubber surface	(B) Air particles resting quietly at the bottom of the balloon
(C) Chemical bonds locking the air particles into a crystal	(D) Gas particles constantly colliding with the inside walls of the balloon

Question 16: Compared to the size of the particles themselves, the distance between gas particles is:

(A) Very large	(B) Zero because they are locked together
(C) Smaller than in a solid	(D) Exactly the same as in a solid

Question 17: Which list correctly orders the states of matter from LEAST kinetic energy to MOST kinetic energy?

(A) Gas → Liquid → Solid	(B) Solid → Liquid → Gas
(C) Liquid → Solid → Gas	(D) Solid → Gas → Liquid

Question 18: What happens to a gas sample when it is released from a small container into a large closed room?

(A) The gas keeps its exact original cube shape in the corner	(B) The gas immediately turns into a solid block
(C) The gas particles expand to fill the entire room	(D) The gas particles stop moving completely

Q2 : Module 1: Energy and Matter

Lesson 1: Particles in Motion

Identify solid, liquid and gas states.

(Pages 19 - 21)

Multiple Choice Questions - MCQ

Structured Concept Explanation (How do Particles in a Gas behave compared to particles in a solid? · Page 19-21):

Matter exists in three common states—solid, liquid, and gas—which are identified by their shape, volume, and particle arrangement. A solid has a definite shape and a definite volume because strong attractions keep its particles closely packed in fixed positions where they only vibrate. A liquid has a definite volume but no definite shape; it takes the shape of its container because its particles are close together but free to flow past one another. A gas has neither a definite shape nor a definite volume; its particles are far apart and move rapidly in all directions to fill the entire volume and shape of any closed container.

Key Ideas from the Student Book:

- In "It's a Gas" (p. 19), squeezing a closed syringe compresses the gas because of large spaces between gas particles.
- In "Still Solid" (p. 20), moving a solid object (like a marble or block) from one container to another does not change its shape or volume.
- Liquids and gases take the shape of their container, but only gases change volume to fill the entire container.

State	Shape	Volume	Particle Arrangement & Freedom
Solid	Definite (fixed) shape	Definite (fixed) volume	Tightly packed; vibrate in fixed positions
Liquid	Takes shape of container	Definite (fixed) volume	Close together; slide and flow past each other
Gas	Takes shape of container	Expands to fill container volume	Far apart; move freely at high speed in all directions

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Remember:

✓ Solid = Definite shape + Definite volume.

✓ Liquid = Indefinite shape + Definite volume.

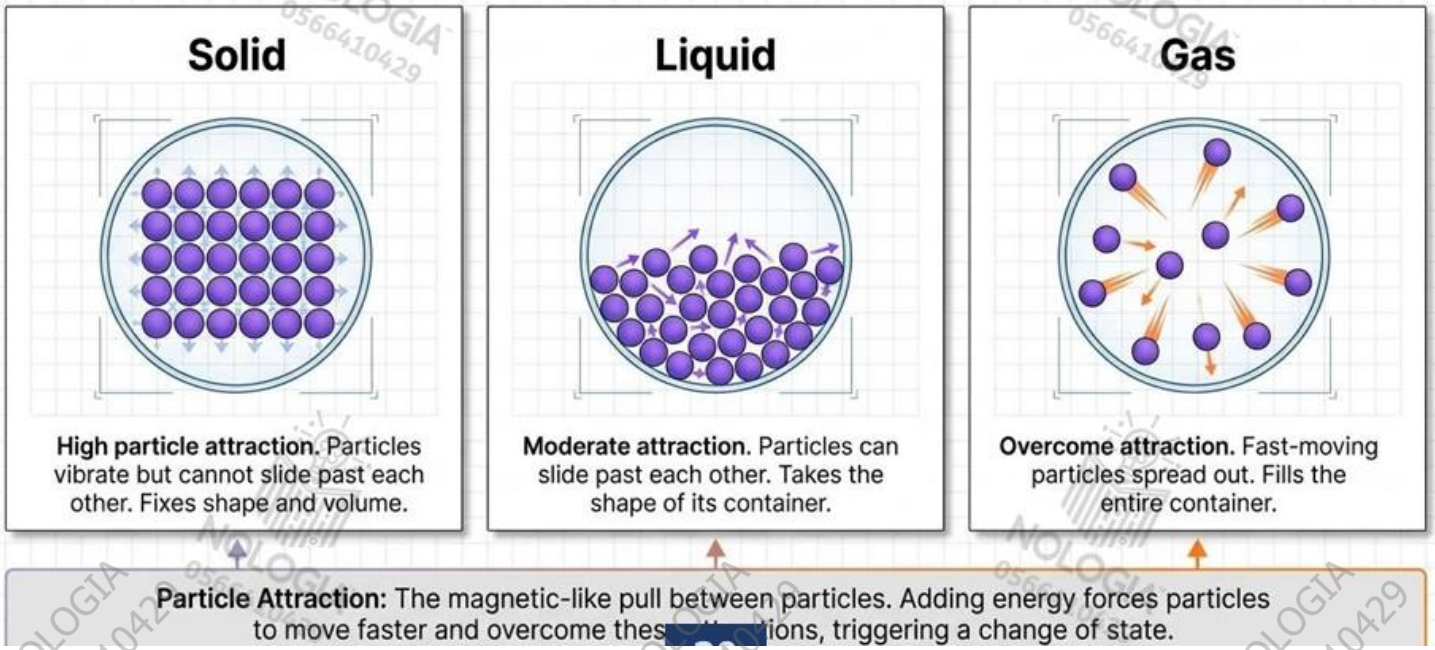
✓ Gas = Indefinite shape + Indefinite volume (compressible).

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

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

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

Particle Arrangement & The Power of Attraction



Questions :

Question 1: Based on what you saw in the Metal Ring video, how do you think you could model the particles in a solid?

(A) Draw particles closely packed together in fixed positions with small motion lines showing they vibrate in place.	(B) Draw only 3 particles very far apart flying in straight lines across the box.
(C) Draw particles pouring out of the bottom of the container like water.	(D) Leave the box completely empty because solids have no particles.

Question 2: Which statement correctly identifies the solid, liquid, and gas states of matter based on their particles, shape, and volume?

(A) A solid has a definite shape and volume (tightly packed vibrating particles), a liquid has a definite volume but takes its container's shape (sliding particles), and a gas has neither definite shape nor definite volume (widely spaced fast particles).	(B) A solid takes the shape of its container, a liquid expands to fill any volume, and a gas has a fixed shape.
(C) All three states of matter have a definite shape and a definite volume.	(D) A gas has tightly packed particles, while a solid has particles that are very far apart.

Question 3: Which state of matter has BOTH a definite shape and a definite volume?

(A) Solid	(B) Liquid
(C) Gas	(D) Plasma

Question 4: Which state of matter has a definite volume but takes the shape of its container?

(A) Solid	(B) Liquid
(C) Gas	(D) Ice

Question 5: Which state of matter has NEITHER a definite shape NOR a definite volume?

(A) Solid	(B) Liquid
(C) Gas	(D) Iron

Question 6: A student places a wooden cube into a round bowl. What happens to the cube's shape and volume?

(A) It spreads out to take the round shape of the bowl	(B) Its volume doubles to fill the bowl
(C) It evaporates immediately into a gas	(D) Both its shape and volume stay the same because it is a solid

Question 7: When 100 mL of water is poured from a tall cylinder into a wide flat dish, what changes?

(A) Both the shape and the volume of the water stay exactly the same	(B) The shape of the water changes, but its volume remains 100 mL
(C) The volume increases to 500 mL, but the shape stays the same	(D) The water turns into a solid crystal

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Question 8: Why can you push the plunger of a sealed air-filled syringe inward slightly, but you cannot do the same when it is filled with a solid?

(A) Gases have large empty spaces between particles and can be compressed	(B) Solids have more empty space between particles than gases
(C) Air has no particles inside the syringe	(D) Solid particles move faster than gas particles

Question 9: In a particle diagram, Sample X shows particles packed tightly in neat rows. What state of matter is Sample X?

(A) Solid	(B) Liquid
(C) Gas	(D) Water vapor

Question 10: In a particle diagram, Sample Y shows particles close together at the bottom of a jar, taking the shape of the bottom. What state is Sample Y?

(A) Solid	(B) Liquid
(C) Gas	(D) Crystalline solid

Question 11: In a particle diagram, Sample Z shows particles spread far apart throughout the entire closed jar. What state is Sample Z?

(A) Solid	(B) Liquid
(C) Gas	(D) Ice cube

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Question 12: How are the forces of attraction between particles in a solid compared to those in a gas?

(A) Attractions are strongest in a gas and weakest in a solid	(B) Attractions are equal in all three states of matter
(C) Neither solids nor gases have any attraction between particles	(D) Attractions are strongest in a solid and weakest in a gas

Question 13: Which of the following is an example of water in the gas state?

(A) Frost on a windowpane	(B) Raindrops falling from a cloud
(C) Invisible water vapor in the air	(D) Hailstones during a storm

Question 14: What property do liquids and solids share?

(A) Both have a fixed, rigid shape	(B) Both have a definite volume that does not easily compress
(C) Both expand to fill any closed room completely	(D) Both have particles that are very far apart

Question 15: What property do liquids and gases share?

(A) Both are fluids whose particles can flow and take the shape of their container	(B) Both have a definite, fixed shape
(C) Both have particles locked in fixed positions	(D) Both have the exact same density

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Question 16: Which substance at room temperature has particles that only vibrate in fixed positions?

(A) Oxygen gas	(B) Drinking water
(C) Helium in a balloon	(D) An iron nail

Question 17: If the lid is removed from a jar filled with gas, what will the gas particles do?

(A) They will stay at the bottom of the jar in a flat layer	(B) They will lock together into a solid cube
(C) They will escape the jar and spread out into the surrounding air	(D) They will sink and freeze immediately

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Q3 : Module 1: Energy and Matter

Lesson 3: Thermal Energy Transfers

Identify energy-transfer types: conduction, convection and radiation.

(Pages 60 - 65)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Direction of Thermal Energy Transfer · Page 60-65):

Heat is the transfer of thermal energy from an object with a higher temperature (source) to an object with a lower temperature (receiver) until both reach thermal equilibrium (the same temperature). Thermal energy is transferred in three ways: (1) Conduction is the transfer of thermal energy by direct collisions between particles of matter in direct contact (most effective in solids). (2) Convection is the transfer of thermal energy by the movement of particles from one part of a fluid (liquid or gas) to another, forming circular convection currents as warm, less dense fluid rises and cooler, denser fluid sinks. (3) Radiation is the transfer of thermal energy by electromagnetic waves, which can travel through matter or across empty space (a vacuum), such as sunlight warming Earth.

Key Ideas from the Student Book:

- Thermal energy ALWAYS flows from the warmer object (higher temperature) to the cooler object (lower temperature).
- Thermal equilibrium is reached when touching objects reach the exact same temperature and net heat flow stops.
- Only radiation can travel through the vacuum of outer space where there are almost no particles.

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Transfer Type	How It Works	Medium Needed	Everyday Example
Conduction	Direct collisions between touching particles	Matter (best in solids)	Metal spoon getting hot in soup; warm water heating a glass beaker
Convection	Warm, less dense fluid rises; cool, denser fluid sinks	Fluids only (liquids & gases)	Boiling water in a pot; warm air rising from a heater
Radiation	Electromagnetic waves (infrared/light)	No medium needed (works in vacuum/space)	Sun warming Earth; feeling heat from a campfire or toaster

Remember:

✓ Conduction = Direct contact / particle collisions.

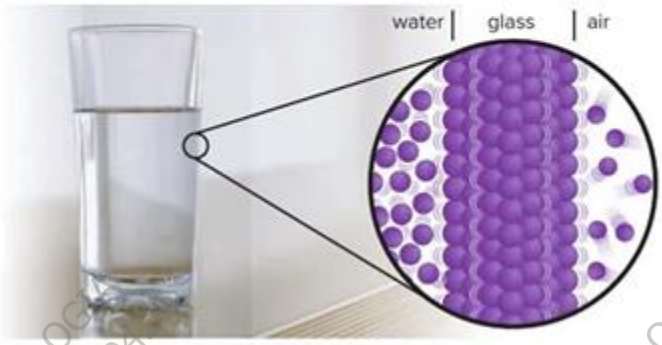
✓ Convection = Fluid movement (warm rises, cool sinks in liquids & gases).

✓ Radiation = Electromagnetic waves (can travel through empty space).

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

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

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

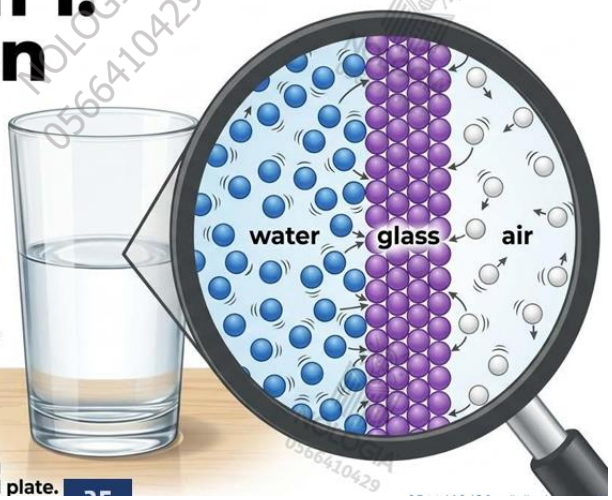


Mechanism 1: Conduction

- Transfer by direct particle collision.
- The Rule: Requires direct physical contact.
- Mediums: Occurs in solids, liquids, and gases.

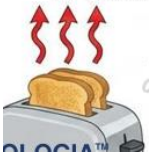


Everyday Example: Hot toast transferring heat directly to a cold plate.

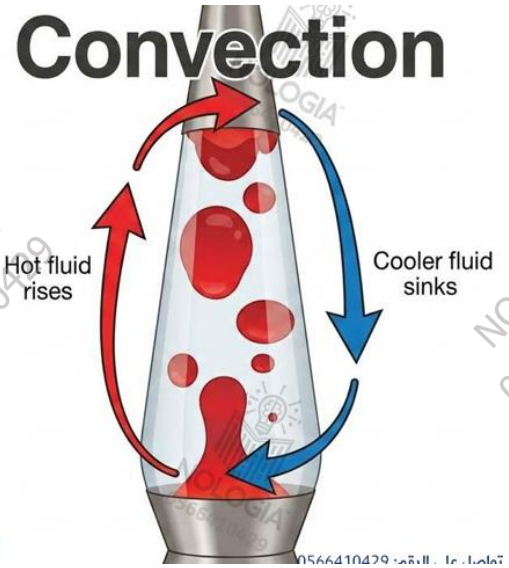


Mechanism 2: Convection

- Transfer by the physical movement of particles from one place to another.
- The Rule: Hot matter rises; cooler matter sinks.
- Mediums: Occurs only in fluids (liquids and gases). Cannot occur in solids.

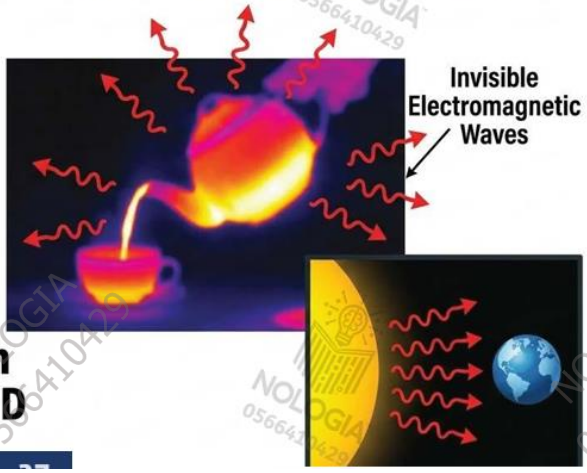


Application: Air warmed by a toaster rises into the room.



Mechanism 3: Radiation

- Transfer by electromagnetic waves.
- The Rule: All matter transfers heat this way (warmer = more radiation).
- Mediums: Travels through solids, liquids, gases—AND a complete vacuum.



Questions :

Question 1: Which statement correctly identifies conduction, convection, and radiation?

(A) Conduction occurs by direct particle collisions, convection occurs by fluid movement, and radiation occurs by electromagnetic waves.	(B) Conduction occurs only in empty space, convection occurs only in rigid solids, and radiation requires direct contact.
(C) Conduction is the rising of warm air, convection is sunlight travelling through space, and radiation is touching a hot pan.	(D) All three types of thermal energy transfer require a liquid medium to move heat from cold to hot objects.

Question 2: What is the transfer of thermal energy by direct collisions between particles of matter?

(A) Conduction	(B) Convection
(C) Radiation	(D) Evaporation

Question 3: What is the transfer of thermal energy by the movement of particles from one part of a fluid to another?

(A) Conduction	(B) Convection
(C) Radiation	(D) Condensation

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Question 4: What is the transfer of thermal energy by electromagnetic waves?

(A) Conduction	(B) Convection
(C) Radiation	(D) Crystallization

Question 5: Which type of thermal energy transfer can travel through the vacuum of outer space from the Sun to Earth?

(A) Conduction	(B) Convection
(C) Radiation	(D) Advection

Question 6: In which states of matter does convection occur?

(A) Solids only	(B) Solids and liquids only
(C) Empty space only	(D) Liquids and gases (fluids) only

Question 7: A metal spoon placed in a cup of hot tea becomes warm at the handle. Which heat transfer process caused this?

(A) Conduction	(B) Convection
(C) Radiation	(D) Transpiration

Question 8: When water is heated in a pot on a stove, warm water rises to the top and cooler water sinks to the bottom. What is this process?

(A) Conduction	(B) Convection
(C) Radiation	(D) Freezing

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Question 9: You warm your hands by holding them to the side of a campfire without touching it. How does most of the heat reach your hands?

(A) Conduction	(B) Convection
(C) Radiation	(D) Sublimation

Question 10: In which direction does thermal energy naturally flow between two objects?

(A) From the lower-temperature object to the higher-temperature object	(B) From the higher-temperature object to the lower-temperature object
(C) Only between objects that already have the exact same temperature	(D) From the smaller object to the larger object regardless of temperature

Question 11: What is reached when two touching objects reach the same temperature and no more net heat flows between them?

(A) Thermal expansion	(B) Specific heat
(C) Vaporization	(D) Thermal equilibrium

Question 12: Why does warm air rise during convection?

(A) Heating causes air particles to spread apart, making warm air less dense than cool air	(B) Warm air is heavier and more dense than cool air
(C) Warm air has less kinetic energy than cool air	(D) Gravity only pulls on warm air upward

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Question 13: Why cannot thermal energy from the Sun reach Earth by conduction or convection?

(A) The Sun is colder than Earth	(B) Sunlight is a liquid fluid
(C) Space between the Sun and Earth is mostly a vacuum with almost no particles	(D) Conduction and convection only work in outer space

Question 14: In the beaker investigation (Page 61), how is thermal energy transferred from the hot water inside the glass beaker to the cold water outside it?

(A) By conduction through direct particle collisions across the glass wall	(B) By nuclear fusion inside the glass
(C) Cold energy flows from the outer beaker into the hot water	(D) Only by electromagnetic waves through a vacuum

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Q4 : Module 1: Energy and Matter

Lesson 4: Thermal Energy Conductivity

Identify conductors and insulators.

(Pages 73)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Encounter The Phenomenon · Page 73)

Kitchenware is made of different materials because some tasks require transferring thermal energy quickly while others require blocking heat flow to protect your hands. A thermal conductor is a material through which thermal energy flows easily (such as metals like iron, copper, aluminum, and steel). Conductors have a low specific heat, meaning they require very little thermal energy to increase in temperature. A thermal insulator is a material through which thermal energy does NOT flow easily (such as wood, plastic, rubber, cotton, wool, ceramic, and air). Insulators have a high specific heat and slow down heat transfer.

Key Ideas from the Student Book:

- Specific heat is the amount of thermal energy required to increase the temperature of 1 kg of a material by 1°C.
- Metal pans are thermal conductors so heat transfers quickly from the stove to cook the food.
- Oven mitts and wooden spoons are thermal insulators so thermal energy does not transfer quickly to burn the cook's hands.

Property	Thermal Conductors	Thermal Insulators
Definition	Materials through which thermal energy flows easily	Materials through which thermal energy does NOT flow easily
Specific Heat	Low specific heat (heats up and cools down quickly)	High specific heat (resists temperature change)
Common Materials	Metals: copper, aluminum, iron, stainless steel, silver	Nonmetals: wood, plastic, cotton, wool, rubber, glass, air
Kitchen Example	Metal cooking pots, cast-iron skillets, metal baking sheets	Wooden spoons, plastic pot handles, cotton oven mitts

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Remember:

✓ Thermal Conductor = Heat flows easily + Low specific heat (Metals: iron, copper, aluminum).

✓ Thermal Insulator = Heat does NOT flow easily + High specific heat (Wood, plastic, cotton, air).

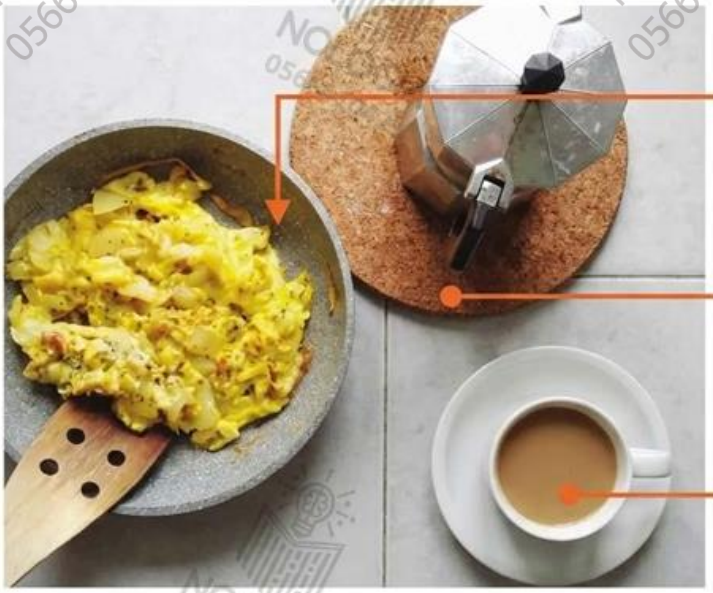
ENCOUNTER THE PHENOMENON | Why is this kitchenware made out of so many different materials?



GO ONLINE
Watch the video *Cooking in the Kitchen* to see this phenomenon in action.

Observe the different types of kitchenware provided by your teacher. Classify the kitchenware based on how you think it would transfer thermal energy. Illustrate your classification system in the space below. Support each classification with an explanation.

Thermal Energy Transfer in the Real World



CONDUCTORS
Metals transfer energy quickly to cook food.

INSULATORS
Insulating materials slow down energy transfer to protect surfaces.

RETAINERS
Ceramic materials retain thermal energy to keep liquids hot.

CORE PRINCIPLE: Thermal energy always transfers based on the unique properties of the interacting materials.

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Questions :

Question 1: Why is a cooking skillet made of metal while a cooking spoon and oven mitt are made of wood and cotton?

(A) Metal is a thermal conductor that transfers heat easily to food, while wood and cotton are thermal insulators that prevent heat from burning your hands.	(B) Metal is a thermal insulator that blocks heat, while wood and cotton are thermal conductors that heat up quickly.
(C) Metal has a very high specific heat, while wood and cotton have the lowest specific heat.	(D) All three materials transfer thermal energy at the exact same rate.

Question 2: What do we call a material through which thermal energy flows easily?

(A) A thermal insulator	(B) A thermal conductor
(C) A thermal reservoir	(D) A crystalline solid

Question 3: What do we call a material through which thermal energy does NOT flow easily?

(A) A thermal insulator	(B) A thermal conductor
(C) A metal alloy	(D) A radiation wave

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Question 4: Which of the following materials is the BEST thermal conductor?

(A) Wood	(B) Cotton
(C) Copper	(D) Plastic

Question 5: Which of the following materials is a good thermal insulator?

(A) Iron	(B) Aluminum
(C) Stainless steel	(D) Wood

Question 6: Why are metal baking sheets used to bake cookies in an oven?

(A) Metals have low specific heat and conduct thermal energy quickly into the cookie dough	(B) Metals block thermal energy from reaching the cookies
(C) Metals are thermal insulators with very high specific heat	(D) Metals prevent conduction from occurring

Question 7: Why does a baker wear thick cotton oven mitts to take a hot tray out of the oven?

(A) Cotton is a thermal conductor that speeds up heat transfer	(B) Cotton is a thermal insulator that slows down the transfer of heat to the baker's hands
(C) Cotton has a lower specific heat than iron	(D) Cotton absorbs cold particles from the oven

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Question 8: What is "specific heat"?

(A) The temperature at which a solid melts into a liquid	(B) The total weight of a material when heated
(C) The amount of thermal energy required to raise the temperature of 1 kg of a material by 1°C	(D) The speed of light waves in empty space

Question 9: How does the specific heat of a thermal conductor compare to the specific heat of a thermal insulator?

(A) A thermal conductor has a lower specific heat than a thermal insulator	(B) A thermal conductor has a much higher specific heat than a thermal insulator
(C) Both have the exact same specific heat	(D) Thermal conductors have infinite specific heat

Question 10: If equal masses of iron (a conductor) and wood (an insulator) absorb the same amount of thermal energy, which one will experience a greater increase in temperature?

(A) The wood, because it is an insulator	(B) The iron, because it has a lower specific heat
(C) Neither will change temperature	(D) Both will increase by the exact same temperature

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Question 11: Why does a metal seatbelt buckle feel much hotter than the cloth car seat on a sunny day, even though both are at the same temperature?

(A) The cloth seat is frozen	(B) Cloth is a better thermal conductor than metal
(C) Metal produces its own heat by chemical reactions	(D) Metal is a thermal conductor that transfers thermal energy rapidly into your skin

Question 12: Why do double-pane windows have a layer of air trapped between two sheets of glass?

(A) Air is a strong metal conductor	(B) Air increases heat loss during winter
(C) Air is a good thermal insulator that reduces heat transfer into or out of a building	(D) Glass cannot let light pass through without air

Question 13: Why does a fluffy winter jacket keep your body warm on a cold day?

(A) The jacket and trapped air act as thermal insulators that slow the loss of thermal energy from your body	(B) The jacket conducts cold energy away from the air
(C) The jacket has a very low specific heat like copper	(D) The jacket generates electricity without batteries

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Question 14: Which group contains ONLY thermal conductors?

(A) Wood, plastic, rubber, wool	(B) Iron, aluminum, copper, silver
(C) Cotton, glass, copper, paper	(D) Air, water, plastic, wood

Question 15: Which group contains ONLY thermal insulators?

(A) Wood, plastic, cotton, rubber	(B) Copper, steel, iron, aluminum
(C) Silver, gold, wood, iron	(D) Aluminum foil, cast iron, brass

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Q5 : Module 1: Energy and Matter

Lesson 2: States of Matter

Identify evaporation, condensation and crystallization.

(Page 40)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Changes between Gases and Liquids · Page 40)

Changes of state occur when thermal energy is added to or removed from matter. Vaporization is the change of state from a liquid to a gas when thermal energy is absorbed. There are two types of vaporization: boiling (which occurs throughout the liquid at its boiling point) and evaporation (which occurs only at the surface of a liquid at temperatures below its boiling point). The reverse process is condensation, the change of state from a gas to a liquid when thermal energy is removed (such as morning dew on grass or clouds forming). Crystallization occurs when a liquid loses thermal energy and freezes into a crystalline solid whose particles are arranged in an orderly, repeating three-dimensional pattern (such as liquid water freezing into ice crystals or snowflakes).

Key Ideas from the Student Book:

- Both evaporation and boiling are forms of vaporization (liquid to gas), but evaporation happens only at the surface at any temperature below boiling.
- Condensation is the reverse of vaporization: cooling a gas slows its particles so attractive forces pull them together into liquid droplets.
- During crystallization, thermal energy is released as liquid water solidifies into six-sided ice crystals.

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Process	State Change	Thermal Energy Change	Where / How It Happens & Examples
Evaporation	Liquid → Gas	Thermal energy is ADDED (absorbed)	Occurs only at the liquid surface below boiling point (puddle drying)
Boiling	Liquid → Gas	Thermal energy is ADDED (absorbed)	Occurs throughout the entire liquid at the boiling point (bubbling water at 100°C)
Condensation	Gas → Liquid	Thermal energy is REMOVED (released)	Gas cools and particles slow down (dew on grass, water drops on cold glass, clouds)
Crystallization	Liquid (or Gas) → Crystalline Solid	Thermal energy is REMOVED (released)	Particles lock into an orderly repeating pattern (ice crystals, snowflakes)

Remember:

✓ Evaporation = Liquid → Gas at the surface (absorbs thermal energy).

✓ Condensation = Gas → Liquid when cooled (releases thermal energy).

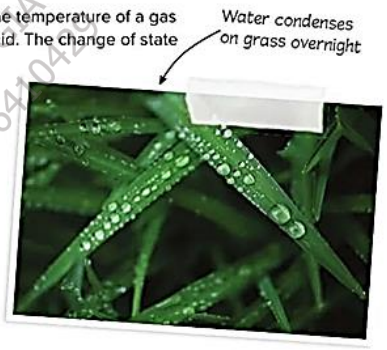
✓ Crystallization = Liquid → Crystalline solid with an orderly particle pattern (releases thermal energy).

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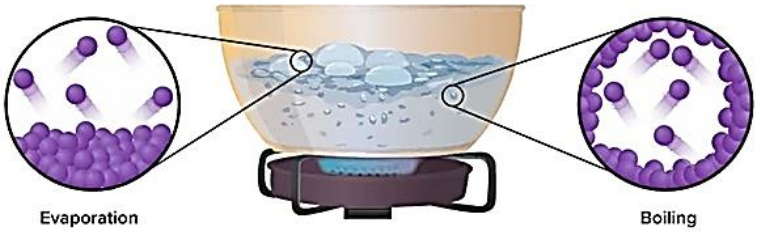
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Changes Between Gases and Liquids When the temperature of a gas becomes low enough, the gas changes to a liquid. The change of state from a gas to a liquid is **condensation.**



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

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



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

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

The Energy Exchange (Opposing Forces)

Evaporation (Liquid → Gas)	Condensation & Crystallization (Gas → Liquid/Solid)
Energy is ABSORBED (from the Sun)	Energy is RELEASED (to the colder atmosphere)
Occurs at warmer surface levels	Occurs as rising air cools at higher altitudes
Creates invisible water vapor	Creates visible clouds, fog, or ice



Reversing the Process: When you see dew on morning grass or spider webs, you are witnessing invisible atmospheric water vapor losing energy overnight and condensing back into a liquid right at the surface.

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Questions :

Question 1: Which statement correctly distinguishes between evaporation, condensation, and crystallization?

(A) Evaporation changes a liquid to a gas at the surface, condensation changes a gas to a liquid when cooled, and crystallization forms a solid with an orderly particle pattern.	(B) Evaporation changes a gas to a liquid, condensation changes a solid to a gas, and crystallization melts a solid into a liquid.
(C) Evaporation and condensation both release thermal energy, while crystallization absorbs thermal energy.	(D) Evaporation occurs only at 100°C throughout a liquid, while condensation occurs only inside solid rocks.

Question 2: What is the change of state from a gas to a liquid called?

(A) Evaporation	(B) Condensation
(C) Melting	(D) Sublimation

Question 3: What is vaporization that occurs ONLY at the surface of a liquid below its boiling point?

(A) Evaporation	(B) Boiling
(C) Condensation	(D) Crystallization

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Question 4: What is the process in which a liquid loses thermal energy and its particles form a solid with an orderly, repeating pattern?

(A) Evaporation	(B) Boiling
(C) Melting	(D) Crystallization

Question 5: How does boiling differ from evaporation?

(A) Boiling changes a gas to a liquid, while evaporation changes a solid to a liquid	(B) Boiling occurs only at 0°C, while evaporation occurs only at 100°C
(C) Boiling occurs throughout the entire liquid at its boiling point, while evaporation occurs only at the surface	(D) Boiling removes thermal energy, while evaporation releases thermal energy

Question 6: On a cool morning, droplets of dew appear on blades of grass. Which process formed the dew?

(A) Evaporation of liquid water from the soil	(B) Condensation of water vapor from the air
(C) Boiling of groundwater	(D) Melting of the grass blades

Question 7: During condensation, what happens to the thermal energy and particle motion of a gas?

(A) Thermal energy is removed and particles move slower	(B) Thermal energy is added and particles move faster
(C) Thermal energy is added and particles stop moving	(D) Neither thermal energy nor particle speed changes

Question 8: During evaporation, what happens to the thermal energy and kinetic energy of the escaping surface particles?

(A) Thermal energy is released and particles freeze in place	(B) Particles lose all kinetic energy and sink to the bottom
(C) Thermal energy is absorbed and the fastest surface particles escape into the air as gas	(D) Particles shrink in size without changing speed

Question 9: What are the two forms of vaporization?

(A) Melting and freezing	(B) Evaporation and boiling
(C) Condensation and crystallization	(D) Sublimation and deposition

Question 10: What is the temperature at which a liquid turns into a gas throughout the entire liquid called?

(A) Melting point	(B) Freezing point
(C) Dew point	(D) Boiling point

Question 11: Which process is the direct reverse of vaporization?

(A) Condensation	(B) Melting
(C) Sublimation	(D) Evaporation

Question 12: When liquid water freezes in clouds to form six-sided snowflakes, which process has occurred?

(A) Evaporation	(B) Condensation
(C) Crystallization	(D) Melting

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Question 13: During a phase change (such as water boiling at 100°C), what happens to the temperature of the water while it is changing state?

(A) The temperature drops rapidly to 0°C	(B) The temperature remains constant until the change of state is complete
(C) The temperature rises immediately to 500°C	(D) The kinetic energy of particles drops to zero

Question 14: Why does sweat on your skin help cool your body on a hot day?

(A) Sweat crystallizes into ice on your skin	(B) Condensation of sweat adds heat to your skin
(C) Sweat blocks all radiation from leaving your body	(D) As sweat evaporates, it absorbs thermal energy from your skin

Question 15: Which pair of processes BOTH require the removal (release) of thermal energy?

(A) Condensation and crystallization (freezing)	(B) Evaporation and melting
(C) Boiling and evaporation	(D) Melting and sublimation

Question 16: Which pair of processes BOTH require the addition (absorption) of thermal energy?

(A) Freezing and condensation	(B) Crystallization and condensation
(C) Melting and evaporation	(D) Freezing and deposition

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Q6 : Module 3: Weather and Climate

Lesson 1: Solar Energy on Earth

Interpret diagrams showing solar energy flow.

(Page 148)

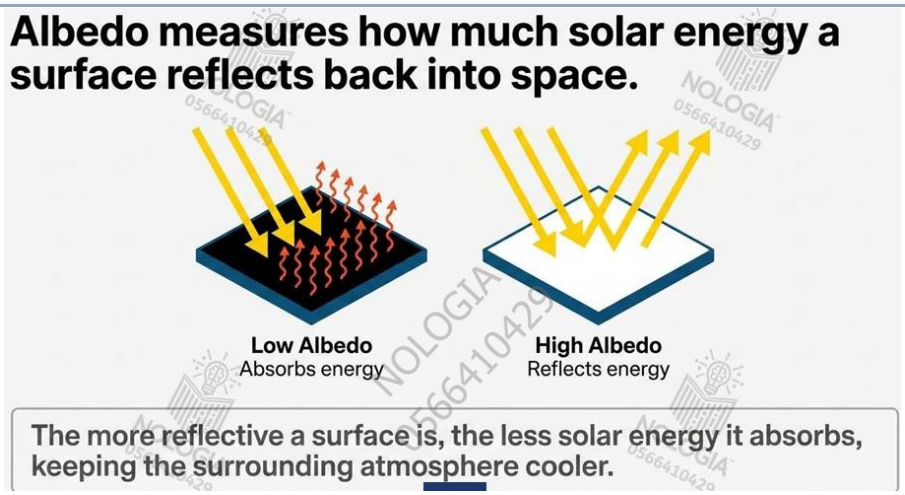
Multiple Choice Questions - MCQ

Structured Concept Explanation (Explain The Phenomenon: Evidence · Page 148)

Solar energy travels from the Sun to Earth across space by radiation (electromagnetic waves). When solar radiation reaches Earth, some is reflected back into space by clouds, air, and bright surfaces (high albedo, such as snow, ice, and white containers), while the rest is absorbed by Earth's surface (especially dark surfaces with low albedo, such as black containers, asphalt, and dark soil). Because Earth is a curved sphere, solar energy strikes the equator at a nearly 90° angle (concentrating energy over a small area, making the tropics warm) and strikes the poles at a low, slanted angle (spreading the same energy over a much larger area, making the poles cold). The sun-warmed surface then heats the air above it by conduction and convection.

Key Ideas from the Student Book:

- In the black vs. white container investigation the black container absorbs more solar radiation and reaches a higher temperature than the white container.
- Albedo is the measure of the reflectivity of a surface: fresh snow has high albedo; dark asphalt has low albedo.
- Sunlight does not heat the atmosphere directly as much as Earth's surface does: the ground absorbs solar radiation and transfers thermal energy to the air by conduction and convection.



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Factor Affecting Solar Heating	High Heating Effect	Low Heating Effect
Surface Color / Albedo	Dark surfaces (black container, dark soil, forest) absorb more solar radiation	Light/shiny surfaces (white container, snow, ice) reflect more solar radiation
Latitude & Sun Angle	Equator (0° latitude): Sunlight hits at ~90° over a small area (most intense)	Poles (90° N/S): Sunlight hits at a low angle (e.g., 30°) spread over a large area (least intense)
Surface Type (Specific Heat)	Land/Sand has low specific heat → warms up and cools down quickly	Water/Ocean has high specific heat (~6× land) → warms up and cools down slowly

Remember:

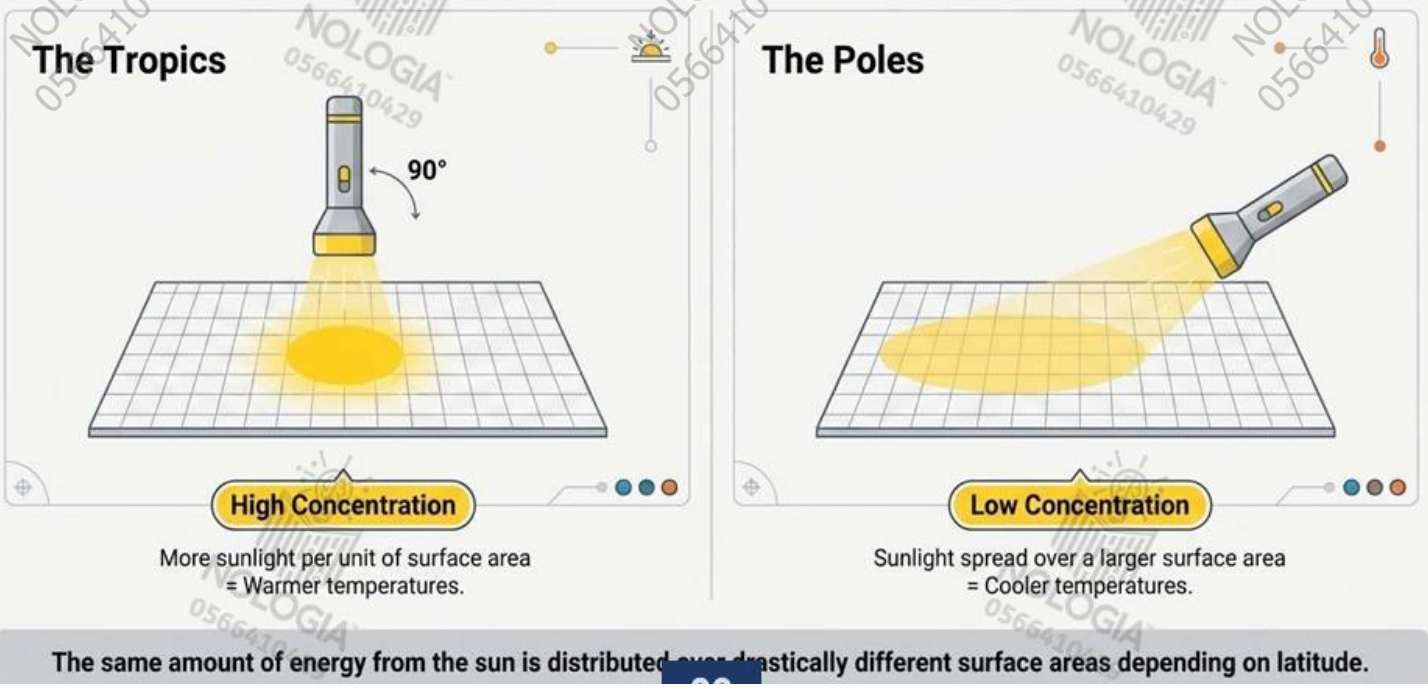
✓ Sun → Earth = Radiation.

✓ Equator = 90° direct rays (small area, hotter) vs. Poles = low-angle slanted rays (large area, colder).

✓ Dark surfaces absorb solar energy; light/white surfaces reflect solar energy.

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The Equator is warmer because it receives highly concentrated solar energy.



The same amount of energy from the sun is distributed over drastically different surface areas depending on latitude.

Different surfaces absorb and release thermal energy at different rates.



Specific Heat **Specific Heat**

The amount of heat needed to raise the temperature of 1 kg of a material by 1°C.

The specific heat of water is about six times higher than the specific heat of land.

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Questions :

Question 1: Based on diagrams of solar energy flow reaching Earth, why are regions near the equator warmer than regions near the poles?

(A) Sunlight strikes the equator at a nearly 90° angle, concentrating solar energy over a smaller surface area than the slanted rays at the poles.	(B) The poles are much closer to the Sun than the equator is.
(C) Sunlight reaches the equator by conduction, while it reaches the poles by convection.	(D) Snow at the poles absorbs 100% of incoming solar radiation.

Question 2: How does solar energy travel from the Sun to Earth's atmosphere and surface?

(A) By conduction through space	(B) By convection currents in space
(C) By radiation as electromagnetic waves	(D) By groundwater flow

Question 3: In the container investigation (Page 148), why did the water inside the black container become warmer than the water inside the white container in sunlight?

(A) The white surface absorbed more solar energy than the black surface	(B) The black surface absorbed more solar radiation, while the white surface reflected more solar radiation
(C) The black container blocked all conduction to the water	(D) White containers generate cold energy

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Question 4: At what angle does sunlight strike Earth's surface near the equator (0° latitude)?

(A) At a 0° angle parallel to the ground	(B) At a very low 15° angle
(C) Sunlight never hits the equator	(D) At a nearly 90° (perpendicular) angle

Question 5: What happens to a beam of sunlight when it strikes Earth at a low angle (such as 30° near the poles)?

(A) The same amount of solar energy is spread out over a much larger surface area	(B) The solar energy is concentrated into a tiny spot
(C) The sunlight becomes twice as hot as at the equator	(D) The beam turns into a convection current in space

Question 6: Why does Earth's curved shape cause unequal heating across different latitudes?

(A) The Sun only shines on the Northern Hemisphere	(B) Different latitudes receive sunlight at different angles, changing how concentrated the energy is
(C) Earth is flat at the equator and pointed at the poles	(D) Clouds only exist at the poles

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Question 7: Which surface on Earth reflects the MOST solar radiation back into space (highest albedo)?

(A) Dark black asphalt road	(B) Dark plowed soil
(C) Fresh white snow and ice	(D) Deep green forest canopy

Question 8: Which surface on Earth absorbs the MOST solar radiation (lowest albedo)?

(A) Dark asphalt pavement	(B) Freshly fallen snow
(C) A white painted roof	(D) A mirror

Question 9: Once Earth's land and water absorb solar radiation, how do they warm the air directly touching the ground?

(A) By conduction	(B) By crystallization
(C) By precipitation	(D) By infiltration

Question 10: What is distance in degrees north or south of the equator called?

(A) Longitude	(B) Latitude
(C) Altitude	(D) Albedo

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Question 11: As you travel from the equator (0°) toward the North Pole (90°N), how does the average amount of solar energy received per square meter change?

(A) It increases steadily	(B) It stays exactly the same at all latitudes
(C) It drops to zero at 30°N and then doubles at 90°N	(D) It decreases because the angle of sunlight becomes lower

Question 12: In a solar oven (Page 147), why is the inside cooking chamber painted black while shiny foil flaps are angled around the outside?

(A) The black interior reflects light out, and the foil absorbs cold air	(B) Both the foil and black paint block sunlight from entering
(C) The shiny flaps reflect sunlight into the box, and the black interior absorbs the solar energy to heat the food	(D) The foil conducts heat from the ground

Question 13: Approximately what happens to incoming solar radiation when it reaches Earth?

(A) 100% is reflected back into space	(B) Some is reflected by clouds, atmosphere, and the surface, while the rest is absorbed by the atmosphere and surface
(C) 100% is absorbed by the ozone layer and none reaches the ground	(D) Solar energy is destroyed at the top of the atmosphere

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Question 14: If a flashlight is shone straight down (90°) onto graph paper and then tilted at a 30° angle, which beam covers FEWER squares with brighter light?

(A) The 90° beam	(B) The 30° tilted beam
(C) Both cover the exact same number of squares	(D) Neither beam touches the paper

Question 15: In the flashlight model of solar energy on Earth, what does the tilted 30° flashlight beam represent?

(A) Sunlight striking Earth at the equator at noon	(B) Heat conduction inside Earth's core
(C) Ocean tides caused by the Moon	(D) Sunlight striking Earth near the poles

Question 16: Why do people in hot, sunny climates often wear white clothes and paint building roofs white?

(A) White surfaces absorb the maximum amount of solar radiation	(B) White surfaces have the lowest albedo
(C) White surfaces reflect more solar radiation and stay cooler	(D) White paint stops convection currents in the ocean

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Q7 : Module 3: Weather and Climate

Lesson 2: Atmospheric and Oceanic Circulation

Identify wind patterns and ocean currents.

(Pages 177 - 179)

Multiple Choice Questions - MCQ

Structured Concept Explanation (What Patterns do Global Winds Form? · Page 177-179):

Unequal heating of Earth's surface creates giant three-cell convection patterns in each hemisphere (between 0°-30°, 30°-60°, and 60°-90° latitude). Air moves from areas of high pressure (cool, sinking air) to areas of low pressure (warm, rising air). Because Earth rotates from west to east, the Coriolis effect deflects moving air to the right in the Northern Hemisphere and to the left in the Southern Hemisphere, creating three major global wind belts in each hemisphere: (1) Trade winds: steady winds that blow from east to west between 30°N and 30°S toward the equator; (2) Prevailing westerlies: winds that blow from west to east between 30° and 60° latitude in both hemispheres; and (3) Polar easterlies: cold winds that blow from east to west near the North and South Poles (60° to 90° latitude).

Key Ideas from the Student Book:

- Winds are named for the direction FROM which they blow (easterlies blow from east to west; westerlies blow from west to east).
- The Coriolis effect is caused by Earth's rotation: it curves winds to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.
- Global winds blow across the ocean surface and drive major surface ocean currents.

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Global Wind Belt	Latitude Range	Wind Direction	Key Characteristics
Trade Winds	0° to 30° N and 0° to 30° S	East to West (toward equator)	Warm, steady winds; converge near the equator
Prevailing Westerlies	30° to 60° N and 30° to 60° S	West to East (toward poles)	Move weather systems across mid-latitudes (e.g., USA/Europe)
Polar Easterlies	60° to 90° N and 60° to 90° S	East to West (away from poles)	Cold, dense air sinking at the poles and blowing toward 60°

Remember:

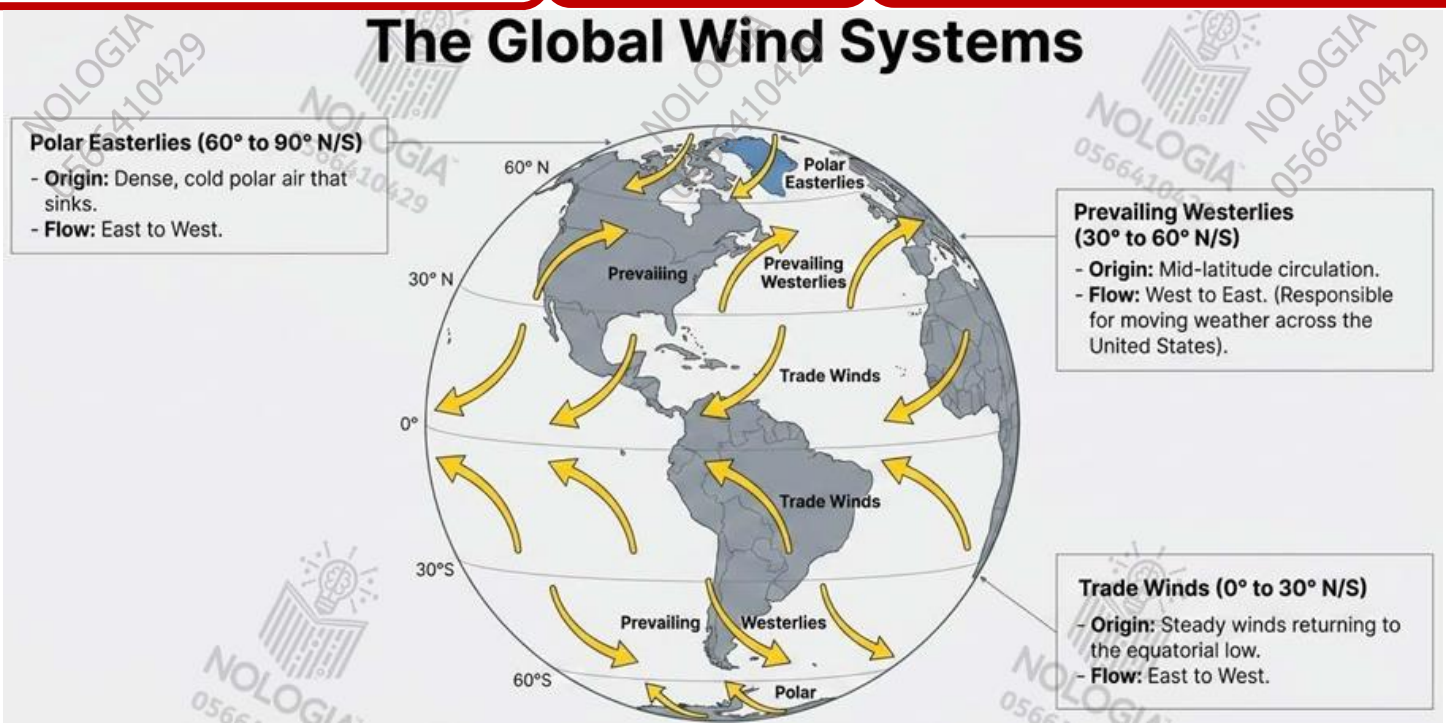
✓ 0°-30° = Trade winds (East → West).

✓ 30°-60° = Prevailing westerlies (West → East).

✓ 60°-90° = Polar easterlies (East → West, cold).

✓ Coriolis Effect = Deflects winds right in Northern Hemisphere, left in Southern Hemisphere.





Questions :

Question 1: Which global wind belt blows steadily from east to west between 30°N and 30°S latitude?

(A) Prevailing westerlies	(B) Trade winds
(C) Polar easterlies	(D) Local sea breezes

Question 2: Which global winds blow from WEST to EAST between 30° and 60° latitude in both hemispheres?

(A) Prevailing westerlies	(B) Trade winds
(C) Polar easterlies	(D) Equatorial doldrums

Question 3: Which cold global winds blow from EAST to WEST near the North and South Poles (60° to 90° latitude)?

(A) Trade winds	(B) Prevailing westerlies
(C) Polar easterlies	(D) Valley breezes

Question 4: What causes global winds and ocean currents to curve rather than travel in straight north-south lines?

(A) The gravitational pull of Mars	(B) The Coriolis effect caused by Earth's rotation
(C) Ocean tides only	(D) Conduction inside Earth's mantle

Question 5: In which direction does the Coriolis effect deflect moving winds in the Northern Hemisphere?

(A) Straight up into space	(B) To the left
(C) Directly toward the center of Earth	(D) To the right

Question 6: In which direction does the Coriolis effect deflect moving winds in the Southern Hemisphere?

(A) To the right	(B) To the left
(C) Straight north without curving	(D) Downward into the ocean

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Question 7: How many major atmospheric convection cells exist in EACH hemisphere from the equator to the pole?

(A) 1 single cell	(B) 2 convection cells
(C) 3 convection cells (0°-30°, 30°-60°, and 60°-90°)	(D) 10 convection cells

Question 8: What is the fundamental cause that drives global winds in Earth's atmosphere?

(A) Unequal heating of Earth's surface by the Sun	(B) Earthquakes on the ocean floor
(C) Volcanic eruptions at the poles	(D) Reflections from the Moon

Question 9: Air in the atmosphere always blows from areas of:

(A) Low pressure to areas of high pressure	(B) Warm rising air to warm rising air
(C) High pressure to areas of low pressure	(D) Low density to even lower density

Question 10: At the equator (0°), warm air rises and creates a belt of:

(A) High pressure	(B) Low pressure
(C) Polar easterlies	(D) Freezing ice caps

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Question 11: At the North and South Poles (90°), cold dense air sinks and creates areas of:

(A) High pressure	(B) Low pressure
(C) Trade winds	(D) Tropical rainforests

Question 12: Around 30°N and 30°S latitude, cool dry air sinks back toward Earth's surface, creating high-pressure zones often associated with:

(A) Constant blizzards and ice sheets	(B) Hurricanes forming on land
(C) Polar ice caps	(D) Clear skies and many of the world's major deserts

Question 13: Which narrow bands of high-speed winds blow from west to east high in the upper troposphere near the boundaries of convection cells?

(A) Sea breezes	(B) Land breezes
(C) Jet streams	(D) Upwelling currents

Question 14: During the day at a beach, land heats up faster than water. Which local wind blows from the cool ocean toward the warm land?

(A) A sea breeze	(B) A land breeze
(C) A polar easterly	(D) A mountain avalanche

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Question 15: At night at a beach, land cools down faster than the ocean water. Which local wind blows from the cool land toward the warmer ocean?

(A) A sea breeze	(B) A land breeze
(C) A trade wind	(D) A prevailing westerly

Question 16: How do global winds affect the surface of the oceans?

(A) Global winds stop all ocean water from moving	(B) Global winds freeze the equator into solid ice
(C) Global winds only affect groundwater beneath rocks	(D) Global winds push ocean water to create surface ocean currents

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Q8 : Module 1: Energy and Matter

Lesson 1: Particles in Motion

Explain, with examples, how temperature shows particle motion.

(Page 14)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Three-Dimensional Thinking · Page 14)

All particles in matter are constantly moving and therefore have kinetic energy (the energy of motion). Temperature is the measure of the average kinetic energy of the particles in a material. When a substance is heated, its particles move faster, have greater average kinetic energy, and register a higher temperature. When a substance is cooled, its particles move slower, have lower average kinetic energy, and register a lower temperature. For example, a drop of red food coloring spreads much faster in hot water (80°C) than in cold water (20°C) because the faster-moving water particles in the 80°C beaker collide more frequently and forcefully with the dye particles. In particle diagrams, more motion lines behind a particle indicate faster speed, higher kinetic energy, and higher temperature.

Key Ideas from the Student Book:

- Temperature measures the AVERAGE kinetic energy of particles in a substance, not the total thermal energy.
- In the food coloring experiment , heating the water increases particle speed, causing the red dye to mix quickly throughout the 80°C beaker.
- In particle models , longer arrows or more curved motion lines represent faster-moving particles at a higher temperature.

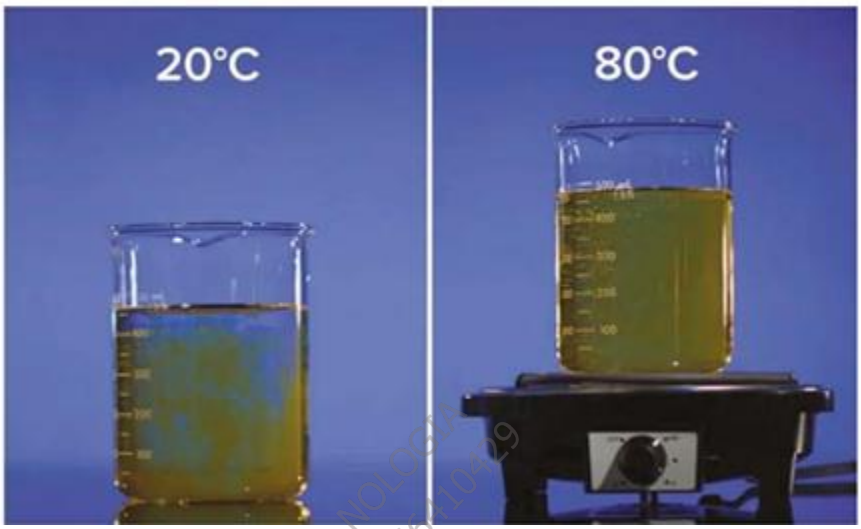
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Condition	Particle Speed & Collisions	Average Kinetic Energy	Motion Lines in Model & Dye Spread
Hot Water (80°C) / Warm Substance	Particles move faster and collide more often	Higher average kinetic energy	More motion lines (e.g., 3 lines); food coloring spreads rapidly
Cold Water (20°C) / Cold Substance	Particles move slower and collide less often	Lower average kinetic energy	Fewer motion lines (e.g., 1-2 lines); food coloring spreads slowly

Remember:

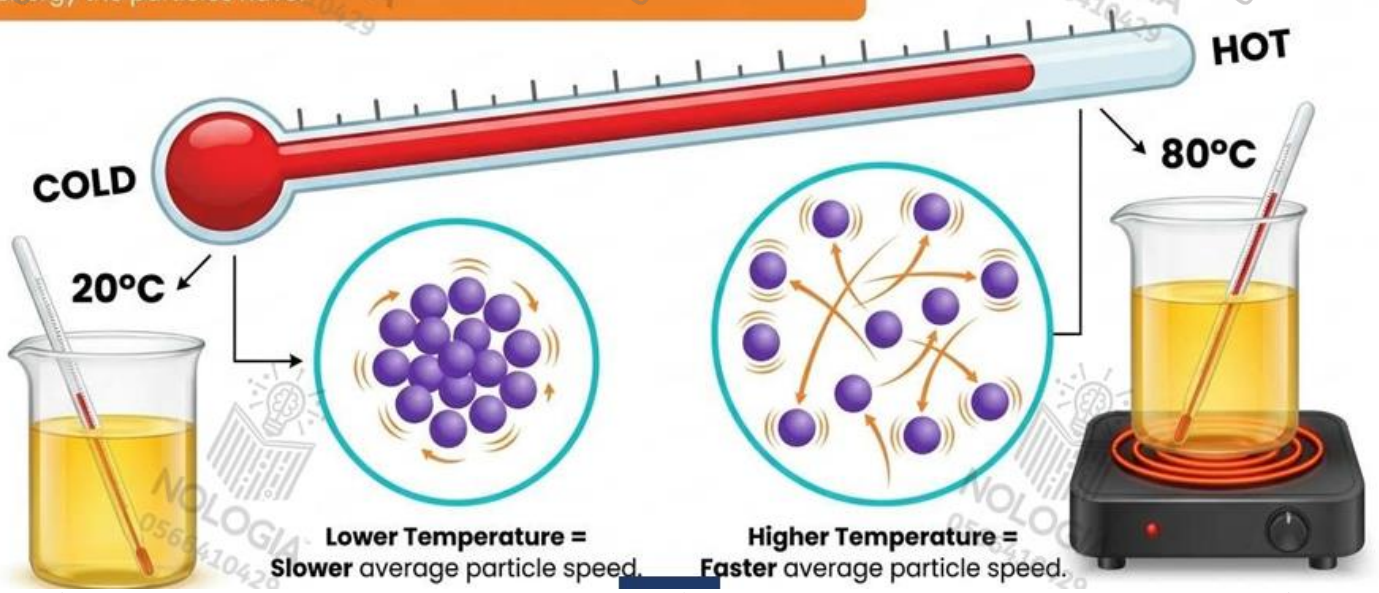
✓ Higher Temperature = Faster particle motion = Higher average kinetic energy = Faster diffusion of dye.

✓ Lower Temperature = Slower particle motion = Lower average kinetic energy = Slower diffusion of dye.

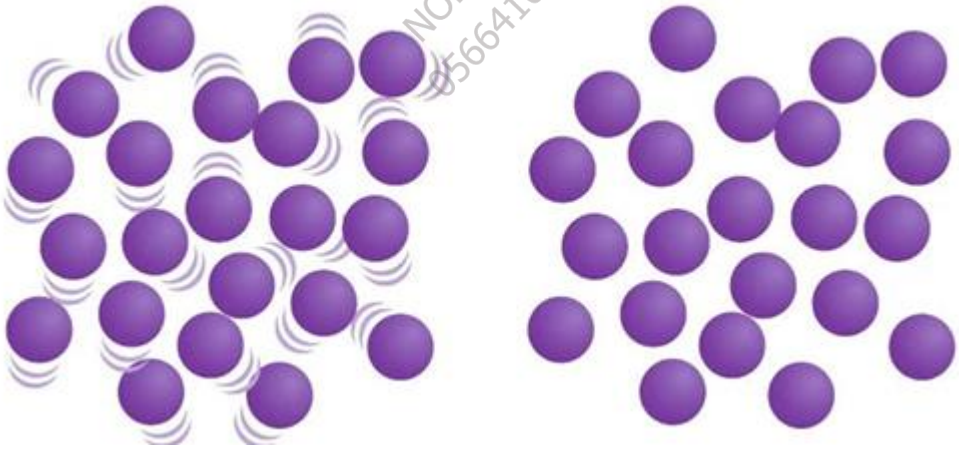


Temperature: Measuring the Motion

Temperature: The measure of the average kinetic energy of the particles in a material. It depends entirely on how much kinetic energy the particles have.



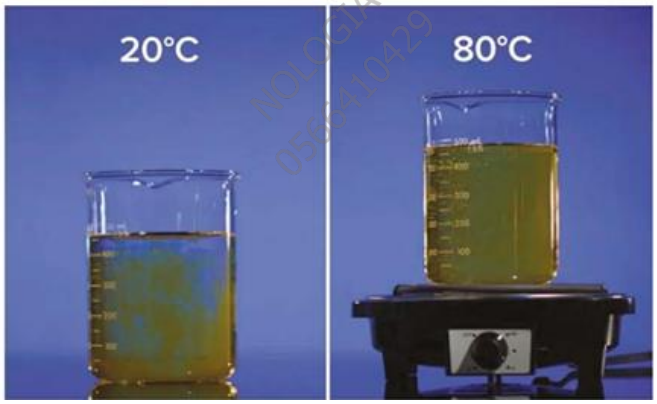
Questions :



Question 1: 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. Which statement is correct?

(A) Draw 3 (or more) motion lines on each particle in the right model (since the left model has 2 motion lines) and circle the right model because faster-moving particles have more kinetic energy (and higher temperature).	(B) Draw 1 motion line on each particle in the right model and circle the left model.
(C) Do not draw any motion lines on the right model because warmer particles stop vibrating.	(D) Draw 2 motion lines on the right model and circle the left model because temperature is unrelated to kinetic energy.

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Question 2: a drop of red food coloring is added to cold water (20°C) and hot water (80°C). Why does the food coloring spread much faster in the 80°C water?

(A) At 80°C, water particles have greater average kinetic energy, move faster, and collide more frequently with the dye particles.	(B) At 20°C, cold water particles move faster and have more kinetic energy than at 80°C.
(C) Temperature has no effect on particle speed or kinetic energy.	(D) Particles in hot water stop moving and allow the dye to sink.

Question 3: What is the scientific definition of temperature?

(A) The total mass of all particles in a container	(B) The amount of empty space between gas particles
(C) The measure of the average kinetic energy of the particles in a material	(D) The force of gravity pulling on a liquid

Question 4: What is kinetic energy?

(A) The energy an object or particle has due to its motion	(B) Energy stored only in motionless rocks
(C) The weight of a thermometer	(D) The color of a liquid dye

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Question 5: When the temperature of a substance increases, what happens to the speed of its particles?

(A) The particles move slower	(B) The particles move faster
(C) The particles stop moving	(D) The particles shrink in mass

Question 6: When a liquid is cooled from 60°C to 10°C, what happens to the average kinetic energy of its particles?

(A) The average kinetic energy increases	(B) The average kinetic energy doubles
(C) The average kinetic energy stays the same	(D) The average kinetic energy decreases

Question 7: Why did the red food coloring spread slowly in the 20°C water beaker?

(A) Cold water has no particles in it	(B) Cold water particles move at the speed of light
(C) Cold water particles move more slowly and collide less forcefully with the dye particles	(D) Food coloring is a solid that cannot dissolve in water

Question 8: Do all particles in a glass of water at 25°C move at the exact same speed?

(A) Yes, every single particle moves at the exact same speed	(B) No, individual particles move at different speeds, so temperature measures their AVERAGE kinetic energy
(C) No, because water particles at 25°C do not move at all	(D) Yes, unless the glass is broken

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Question 9: Four samples of water have temperatures of 5°C, 25°C, 50°C, and 90°C. In which sample do the water molecules have the HIGHEST average kinetic energy?

(A) 5°C	(B) 25°C
(C) 50°C	(D) 90°C

Question 10: Four samples of water have temperatures of 5°C, 25°C, 50°C, and 90°C. In which sample do the water molecules move the SLOWEST?

(A) 5°C	(B) 25°C
(C) 50°C	(D) 90°C

Question 11: What happens to the liquid inside a thermometer when it is placed in hot water?

(A) Its particles slow down, move closer together, and sink	(B) Its particles freeze into a solid crystal
(C) Its particles move faster, spread slightly farther apart (thermal expansion), and rise up the tube	(D) The number of particles inside the thermometer doubles

Question 12: What is "thermal expansion"?

(A) An increase in the mass of particles when cooled	(B) An increase in the volume of a substance when heated because faster-moving particles move slightly farther apart
(C) The shrinking of a balloon when placed in a freezer	(D) The creation of new atoms when water boils

Question 13: What happens to the volume of most materials when they are cooled (thermal contraction)?

(A) Particles slow down and move closer together, so the volume decreases slightly	(B) Particles speed up and spread far apart
(C) The mass of each particle decreases by half	(D) The material turns into plasma

Question 14: A tea bag is placed in a cup of hot water (85°C) and another tea bag is placed in a cup of iced water (4°C). Why does the tea brew much faster in the hot water?

(A) Iced water has higher kinetic energy than hot water	(B) Tea particles only dissolve when water is frozen
(C) Gravity is stronger in hot water than in cold water	(D) Water molecules at 85°C have higher kinetic energy and collide more rapidly with the tea particles

Question 15: If two cups of water both have a temperature of 40°C, how does the average kinetic energy of the particles in Cup 1 compare to Cup 2?

(A) Cup 1 has twice the average kinetic energy	(B) Cup 2 has zero average kinetic energy
(C) Both cups have the exact same average kinetic energy because their temperatures are equal	(D) Average kinetic energy cannot be compared using temperature

Q9 : Module 2: The Water Cycle

Lesson 1: Water in the Atmosphere

Interpret models or diagrams of state changes.

(Page 119)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Three-Dimensional Thinking · Page 119):

A sealed plastic bag containing a small amount of water taped to a sunny window acts as a miniature model of the water cycle showing changes of state. When sunlight shines on the bag, the liquid water at the bottom absorbs thermal energy, causing its molecules to move faster and escape into the air inside the bag as invisible water vapor (evaporation). When the warm water vapor rises and touches the cooler upper sides of the bag, it loses thermal energy, slows down, and turns back into liquid water droplets sticking to the inside of the bag (condensation).

Key Ideas from the Student Book:

- In Question 2 on page 119, Jorge pours water into a sealable plastic bag, seals it, and tapes it to a sunny window; after an hour, water beads appear along the inside of the bag.
- Two state changes occurred in sequence: evaporation (liquid water → water vapor) followed by condensation (water vapor → liquid water beads).
- Because the bag is sealed, matter (water) is conserved while cycling between liquid and gas states.

Step in Window Bag Model	Observation in Bag	State Change Process	Energy Change
Step 1: Sunlight heats water at bottom	Liquid water turns into invisible water vapor in the air inside the bag	Evaporation (Liquid → Gas)	Thermal energy is absorbed from sunlight
Step 2: Vapor touches cooler upper bag wall	Beads of liquid water form along the inside of the bag	Condensation (Gas → Liquid)	Thermal energy is released to cooler air/plastic

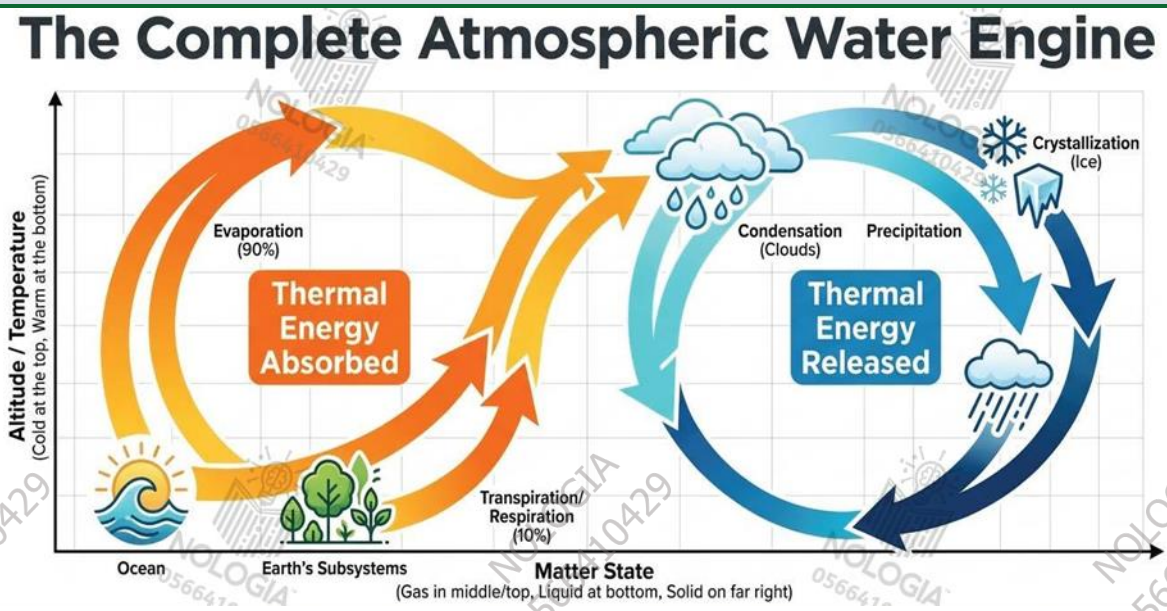
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Remember:

✓ Water beads inside a sunny sealed bag = Evaporation (heated by sun) + Condensation (cooled on bag wall).

✓ Correct option on Page 119 Question 2 = B (evaporation and condensation).



Questions :

Question 1: 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. Which processes are represented by Jorge's model?

(A) transpiration and respiration	(B) condensation and crystallization
(C) respiration and evaporation	(D) evaporation and condensation



Question 2: 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.

Question 3: In Jorge's window-bag model, what energy source causes the liquid water at the bottom of the bag to evaporate?

(A) Thermal energy from sunlight	(B) Gravity pulling the water upward
(C) Geothermal energy from rocks	(D) Magnetic energy from the window glass

Question 4: Which process directly formed the visible beads of liquid water on the upper inside walls of the plastic bag?

(A) Evaporation	(B) Transpiration
(C) Condensation	(D) Melting

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Question 5: Before the water beads appeared on the inside of the bag, in what state of matter was the water as it rose from the bottom of the bag?

(A) Solid ice crystals	(B) Gas (invisible water vapor)
(C) Liquid streams flowing upward	(D) Plasma

Question 6: What happens to the total mass of water inside Jorge's plastic bag if the bag remains tightly sealed?

(A) The mass doubles after one hour	(B) The mass drops to zero when evaporation starts
(C) The mass increases because sunlight has mass	(D) The total mass of water stays constant because no matter can enter or leave

Question 7: When the water beads on the side of the bag grow heavy enough and slide back down to the bottom of the bag, what natural water-cycle processes do they model?

(A) Precipitation and surface runoff	(B) Transpiration and photosynthesis
(C) Sublimation and melting	(D) Fossil fuel combustion

Question 8: Why was "transpiration" NOT one of the processes occurring inside Jorge's plastic bag?

(A) Transpiration only happens in outer space	(B) There were no living plants inside the bag releasing water vapor from leaves
(C) Transpiration is the freezing of liquid water into ice	(D) Sunlight prevents transpiration from happening

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Question 9: Why was "crystallization" NOT occurring inside Jorge's sunny window bag?

(A) Crystallization is the boiling of water at 100°C	(B) Water can never form crystals
(C) The temperature inside the sunny bag stayed above 0°C, so no ice crystals formed	(D) Crystallization only occurs in open containers

Question 10: If Jorge placed the exact same sealed bag in a dark, cold closet instead of a sunny window, how would the results differ?

(A) Much less evaporation and condensation would occur because there is less thermal energy	(B) The water would boil immediately
(C) More evaporation would occur in the dark cold closet	(D) The plastic bag would melt

Question 11: In a diagram of state changes, an arrow pointing from "Liquid Water" to "Water Vapor" with a "+ Thermal Energy" label represents:

(A) Condensation	(B) Evaporation (or vaporization)
(C) Freezing	(D) Crystallization

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Question 12: In a diagram of state changes, an arrow pointing from "Water Vapor" to "Liquid Water Droplets" with a "– Thermal Energy" label represents:

(A) Evaporation	(B) Melting
(C) Boiling	(D) Condensation

Question 13: How does the spacing of water molecules change during evaporation inside the bag?

(A) The molecules lock tightly into a fixed crystal grid	(B) The molecules move closer together
(C) The molecules move much farther apart as they change from liquid to gas	(D) The spacing does not change at all

Question 14: How does the spacing of water molecules change during condensation on the inside wall of the bag?

(A) The molecules slow down and move closer together as they change from gas to liquid	(B) The molecules spread infinitely far apart
(C) The molecules break apart into hydrogen and oxygen flames	(D) The molecules stop vibrating and form six-sided snow crystals

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Question 15: In nature, what do the beads of condensed water on the upper part of the bag represent?

(A) Deep groundwater aquifers	(B) Cloud droplets forming in the cooler atmosphere
(C) Lava cooling into rock	(D) Ocean tides

Question 16: What is the process called when plants release water vapor into the atmosphere through stomata in their leaves?

(A) Condensation	(B) Crystallization
(C) Precipitation	(D) Transpiration

Question 17: Which two forces drive the continuous movement of water in both the window-bag model and Earth's water cycle?

(A) Wind turbines and ocean waves	(B) Magnetism and friction
(C) Thermal energy from the Sun and the pull of gravity	(D) Airplanes and clouds

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Q10 : Module 1: Energy and Matter

Lesson 3: Thermal Energy Transfers

Describe energy flow from hot to cold.

(Page 60)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Three-Dimensional Thinking · Page 60):

Thermal energy always flows spontaneously in one direction: from a warmer object (higher temperature, the Source Object) to a cooler object (lower temperature, the Receiver Object). As thermal energy transfers, the kinetic energy and temperature of the source object decrease, while the kinetic energy and temperature of the receiver object increase, until both reach thermal equilibrium. There is no such thing as "coldness" flowing into an object—an object cools down only when thermal energy flows out of it into a cooler environment. For example, when liquid water at 10°C is placed into a freezer at 0°C, thermal energy flows from the warmer 10°C water (source) to the colder 0°C air in the freezer (receiver) until the water freezes.

Key Ideas from the Student Book:

- Heat always flows from higher temperature (hotter) to lower temperature (colder)—never from cold to hot on its own.
- In the freezer example (Page 60), 10°C is warmer than 0°C, so the 10°C liquid water is the source object that loses thermal energy to the 0°C freezer air.
- When you hold an ice cube in your hand (37°C), thermal energy flows from your warm hand into the 0°C ice cube, melting the ice and making your hand feel cold.

Component	Role in Heat Transfer	Change in Kinetic Energy & Temperature
Source Object (Warmer / Higher Temp)	Provides / loses thermal energy (e.g., 10°C water in freezer)	Particles slow down; kinetic energy and temperature DECREASE
Receiver Object (Cooler / Lower Temp)	Gains / absorbs thermal energy (e.g., 0°C freezer air)	Particles speed up; kinetic energy and temperature INCREASE

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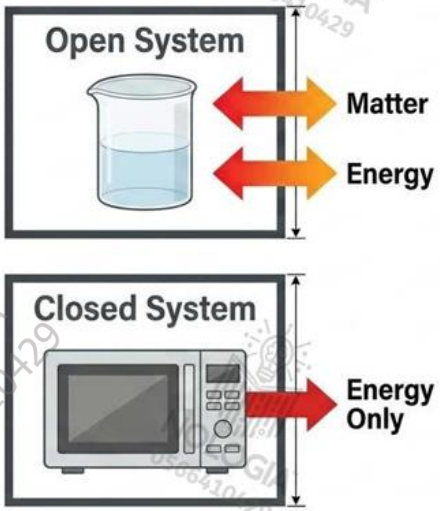
Remember:

✓ Heat Flow Rule: ALWAYS Warmer (Higher Temp) → Cooler (Lower Temp).

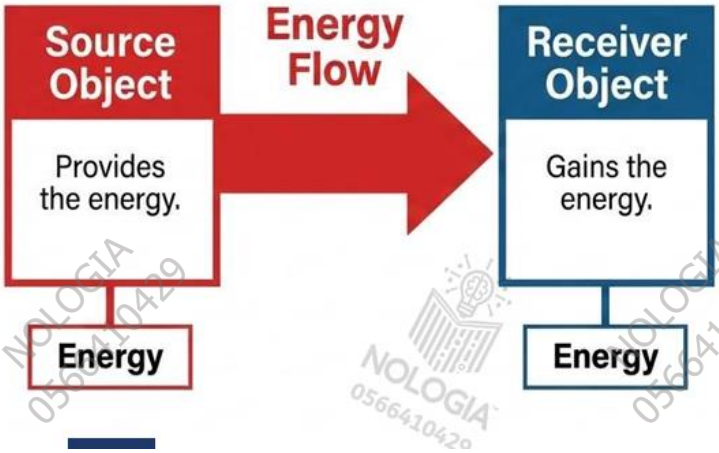
✓ 10°C water in a 0°C freezer: Thermal energy flows OUT of the 10°C water INTO the 0°C freezer air.

Defining the System

Types of Systems

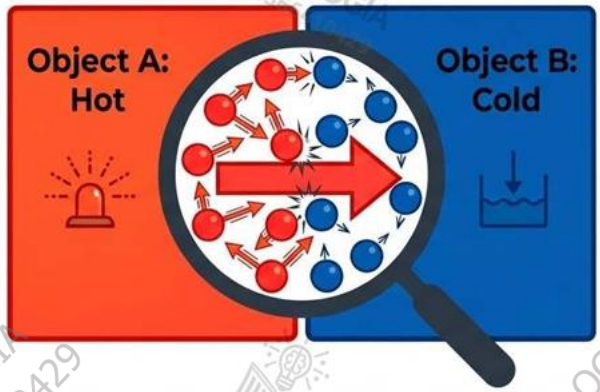


The Energy Flow Model

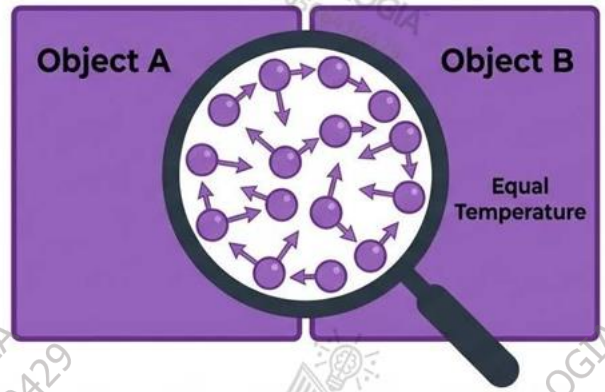


Thermal Equilibrium

1. Transferring Phase



2. Thermal Equilibrium



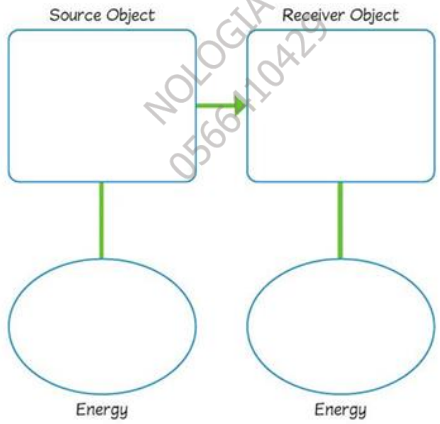
- **Thermal Equilibrium:** Temperatures are perfectly equal.
- **The Particle Reality:** Particles continue to collide and transfer kinetic energy back and forth, but the average kinetic energy of both materials remains exactly the same.

Questions :



Question 1: 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.

(A) Draw arrows pointing INWARD from the 0°C freezer air into the 10°C water.	(B) Draw arrows pointing OUTWARD from the warmer 10°C water in the tray (source object) into the colder 0°C freezer air (receiver object).
(C) Draw arrows pointing from the 0°C air to the 10°C water because cold flows to warm.	(D) Do not draw any arrows because both temperatures are cold.



Question 2: THREE-DIMENSIONAL THINKING (Page 60): In the energy flow diagram , what happens to the kinetic energy of the source object and the receiver object?

(A) The warmer source object loses thermal energy (its kinetic energy decreases), while the cooler receiver object gains thermal energy (its kinetic energy increases).	(B) The source object gains kinetic energy, while the receiver object loses kinetic energy.
(C) Both objects increase in temperature and kinetic energy forever.	(D) Thermal energy flows from the cooler receiver object to the warmer source object.

Question 3: In any thermal energy transfer, what is the "source object"?

(A) The warmer object that provides thermal energy	(B) The cooler object that gains thermal energy
(C) The object with zero kinetic energy	(D) The thermometer used to measure mass

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Question 4: In any thermal energy transfer, what is the "receiver object"?

(A) The hotter object that loses thermal energy	(B) The cooler object that gains thermal energy
(C) The object whose particles slow down	(D) The Sun in outer space

Question 5: What happens to the kinetic energy of the particles in the SOURCE object as heat is transferred?

(A) The kinetic energy of its particles increases	(B) The kinetic energy of its particles doubles
(C) The kinetic energy of its particles decreases	(D) The kinetic energy of its particles stays unchanged

Question 6: What happens to the kinetic energy of the particles in the RECEIVER object as heat is transferred?

(A) The kinetic energy of its particles increases	(B) The kinetic energy of its particles decreases
(C) The kinetic energy of its particles drops to zero	(D) Its particles stop vibrating completely

Question 7: When you hold a cold ice cube (0°C) in your warm hand (37°C), why does your hand feel cold?

(A) Coldness flows from the ice cube into your hand	(B) Thermal energy flows from the 0°C ice cube into your 37°C hand
(C) Your hand and the ice cube are at thermal equilibrium	(D) Thermal energy flows from your warm hand into the colder ice cube

Question 8: Block X at 80°C is placed in direct contact with Block Y at 25°C. Which way will heat flow?

(A) From Block Y to Block X	(B) From Block X to Block Y
(C) Heat will not flow between them	(D) Heat will flow from both blocks into empty space only

Question 9: When will thermal energy stop flowing between Block X (initially 80°C) and Block Y (initially 25°C)?

(A) When Block X reaches 100°C and Block Y reaches 0°C	(B) After 1 second regardless of temperature
(C) When both blocks reach the exact same temperature (thermal equilibrium)	(D) Thermal energy never stops flowing

Question 10: A cup of hot coffee (75°C) is left on a table in a room where the air is 22°C. Identify the source object and the receiver object.

(A) Source: hot coffee (75°C); Receiver: room air and table (22°C)	(B) Source: room air (22°C); Receiver: hot coffee (75°C)
(C) Both are source objects	(D) Both are receiver objects

Question 11: A glass of cold lemonade (5°C) is placed outside on a hot summer day (35°C). In which direction does thermal energy flow?

(A) From the 5°C lemonade into the 35°C outdoor air	(B) From the 35°C outdoor air into the 5°C lemonade
(C) Cold energy flows out of the lemonade into the Sun	(D) No heat flows because lemonade is a liquid

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Question 12: Two metal spheres touching each other are both at 50°C. What is the net flow of thermal energy between them?

(A) Heat flows rapidly from left to right	(B) Heat flows rapidly from right to left
(C) Both spheres cool down to 0°C instantly	(D) Zero net heat flow because they are already at thermal equilibrium

Question 13: How does a refrigerator or freezer cool food placed inside it?

(A) By pumping cold particles into the food	(B) By increasing the kinetic energy of the food particles
(C) By removing thermal energy from the warmer food into the colder air inside the appliance	(D) By transferring heat from 0°C air into 20°C food

Question 14: If Object A at –5°C touches Object B at –20°C, which object is the source of thermal energy?

(A) Object A (–5°C), because –5°C is a higher temperature than –20°C	(B) Object B (–20°C), because –20 is a larger number
(C) Neither object has any thermal energy below 0°C	(D) Heat flows from –20°C to –5°C

Question 15: What is the scientific term for thermal energy that is being transferred from a warmer object to a cooler object?

(A) Temperature	(B) Heat
(C) Mass	(D) Albedo

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Question 16: When a hot iron horseshoe (300°C) is dropped into a bucket of cool water (20°C), what happens to the temperature of the water and the horseshoe?

(A) Both temperatures increase above 300°C	(B) Both temperatures drop below 20°C
(C) The horseshoe's temperature decreases and the water's temperature increases until they are equal	(D) The water transfers thermal energy into the 300°C horseshoe

Question 17: Which statement about "cold" is scientifically accurate?

(A) Cold is a fluid that flows out of ice cubes into warm rooms	(B) Cold particles travel faster than hot particles
(C) Cold energy is transferred by radiation from snow to the Sun	(D) Cold is simply the absence or lower amount of thermal energy; only heat (thermal energy) flows from warm to cool

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Q11 : Module 1: Energy and Matter

Lesson 4: Thermal Energy Conductivity

Explain direct and inverse proportional relationships between energy, mass and temperature.

(Page 78)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Collect Evidence · Page 78)

The mass of a sample affects both its total thermal energy and how fast its temperature changes when heated or cooled. Two variables are directly proportional when an increase in one causes a proportional increase in the other (both move in the same direction: ↑↑): for example, at a given temperature change, the amount of thermal energy needed is directly proportional to mass (a large pot of water has more mass and requires more thermal energy to boil than a small pot). Similarly, for a fixed mass, temperature change is directly proportional to thermal energy added. Two variables are inversely proportional when an increase in one causes a decrease in the other (opposite directions: ↑↓): for a fixed amount of thermal energy added, the change in temperature is inversely proportional to mass (as mass increases, the temperature change decreases, so a small pot heats up much faster than a large pot on the same burner).

Key Ideas from the Student Book:

- A small pot of water has fewer particles (less mass), so it needs less thermal energy and heats up (or cools down) much faster than a large pot.
- At the same temperature, a larger mass has MORE total thermal energy because it contains more moving particles.
- Direct proportionality graphs as a straight line going up through the origin; inverse proportionality curves downward as mass increases.

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Relationship Type	Variables Compared (with 3rd held constant)	How They Change Together	Example from Kitchen / Lab
Directly Proportional (↑ ↑)	Mass & Thermal Energy Needed (for same ΔT)	As mass increases, thermal energy needed increases	Doubling the mass of water requires twice as much heat to reach 100°C
Directly Proportional (↑ ↑)	Thermal Energy Added & Temperature Change (for same Mass)	As heat added increases, temperature change increases	Heating 100 g of water for 4 min raises its temperature more than heating it for 2 min
Inversely Proportional (↑ ↓)	Mass & Temperature Change (for same Thermal Energy Added)	As mass increases, change in temperature decreases	With the same burner heat, a small pot of water has a large ΔT while a large pot has a small ΔT

Remember:

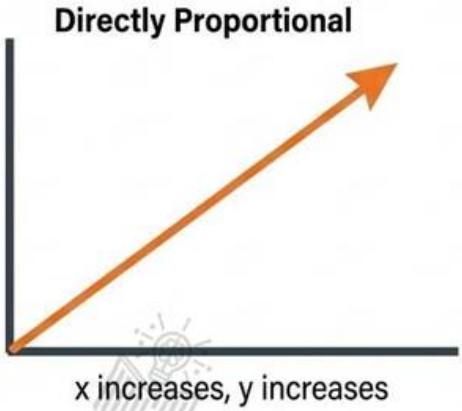
✓ Directly Proportional (↑ ↑): More Mass = More Thermal Energy needed to reach the same temperature.

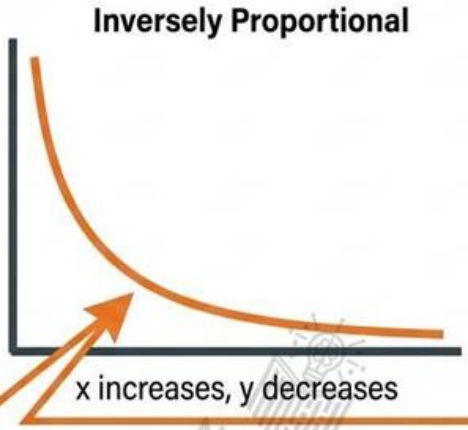
✓ Inversely Proportional (↑ ↓): For the SAME heat input, More Mass = Smaller change in temperature (heats up slower).

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Variable 1: The Impact of Mass on Temperature Change

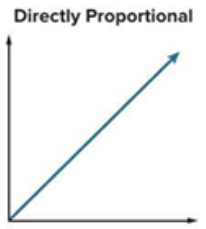
Mass determines the amount of thermal energy in a substance. More particles = more energy required from the surroundings to increase kinetic energy.

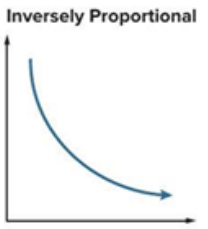




For a constant energy input, the change in temperature vs. mass is an inversely proportional relationship. (e.g., A small pot of water heats up much faster than a large pot of water).

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





Questions :

Question 1: Sketch a particle model to explain the relationship between change in temperature and mass. How does the mass of a material in the kitchenware affect how it transfers thermal energy?

(A) Mass and temperature change are inversely proportional: a sample with smaller mass has fewer particles so each particle gains more kinetic energy while a larger mass has more particles and requires more thermal energy to reach the same temperature.	(B) A sample with larger mass has fewer particles and heats up much faster than a smaller mass.
(C) Mass and temperature change are completely unrelated in kitchenware.	(D) Particles in a smaller pot move slower when heated than particles in a larger pot.

Question 2: Why does a small pot of water reach a boil much faster than a large pot of water on identical stove burners?

(A) The small pot contains less mass (fewer water particles), so it requires directly proportionally less thermal energy to reach 100°C.	(B) The large pot has a lower boiling point than the small pot.
(C) Water in a small pot has a different specific heat than water in a large pot.	(D) The large pot loses mass when heated.

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Question 3: What is the relationship between the mass of a water sample and the amount of thermal energy needed to raise its temperature by 10°C?

(A) Inversely proportional	(B) Directly proportional (as mass increases, thermal energy needed increases)
(C) No relationship exists	(D) As mass increases, thermal energy needed drops to zero

Question 4: For a fixed mass of water (such as 100 g), what is the relationship between the thermal energy added and the change in temperature?

(A) Directly proportional (adding more thermal energy causes a greater temperature increase)	(B) Inversely proportional (adding more heat lowers the temperature)
(C) Unrelated	(D) Adding thermal energy decreases particle speed

Question 5: Why does a small pot of water boil much faster than a large pot of water on identical stove burners?

(A) The small pot has a higher boiling point than 100°C	(B) The large pot has fewer water molecules
(C) The small pot has less mass (fewer water particles), so it needs less thermal energy to reach 100°C	(D) Small pots are thermal insulators

Question 6: A cup of water (200 g) and a bucket of water (5,000 g) are both at 30°C. Which one has MORE total thermal energy, and why?

(A) The cup of water, because it is smaller	(B) Both have the exact same total thermal energy
(C) Neither has any thermal energy at 30°C	(D) The bucket of water, because it has much greater mass (more moving particles) at the same temperature

Question 7: A cup of water (200 g) and a bucket of water (5,000 g) are both at 30°C. How does the AVERAGE kinetic energy of particles in the cup compare to the bucket?

(A) The bucket has 25 times higher average kinetic energy	(B) They are equal because both are at the same temperature (30°C)
(C) The cup has higher average kinetic energy	(D) Both have zero average kinetic energy

Question 8: If 100 g of water and 200 g of water at 20°C are heated on identical hot plates for 3 minutes, how will their temperature increases compare?

(A) The 100 g sample will have twice the temperature increase of the 200 g sample	(B) The 200 g sample will have twice the temperature increase of the 100 g sample
(C) Both samples will reach the exact same temperature	(D) Neither sample will change temperature

Question 9: What does an "inversely proportional" relationship between two variables X and Y mean?

(A) As variable X increases, variable Y also increases	(B) Both variables stay constant forever
(C) As variable X increases, variable Y decreases	(D) Variable X equals zero at all times

Question 10: What does a "directly proportional" relationship between two variables X and Y mean?

(A) As variable X increases, variable Y increases at a constant ratio	(B) As variable X increases, variable Y decreases
(C) Variable X and variable Y are completely unrelated	(D) Variable Y is always negative

Question 11: Two bowls of hot soup—one small (150 g) and one large (600 g)—start at 80°C on a table. Which bowl will cool down to room temperature faster?

(A) The large 600 g bowl, because larger mass cools faster	(B) The small 150 g bowl, because it has less mass and less total thermal energy to lose
(C) Both bowls will cool at the exact same rate	(D) Neither bowl will cool down

Question 12: If it takes 4,200 Joules of thermal energy to raise 1 kg of water by 1°C, how much thermal energy is needed to raise 3 kg of water by 1°C?

(A) 1,400 Joules	(B) 4,200 Joules
(C) 8,400 Joules	(D) 12,600 Joules (3 times as much energy)

Question 13: In an experiment investigating how mass affects temperature change, what is the independent variable (the variable you intentionally change)?

(A) The mass of the substance	(B) The resulting change in temperature
(C) The brand of stopwatch	(D) The color of the laboratory walls

Question 14: In an experiment investigating how mass affects temperature change, what is the dependent variable (the variable you measure)?

(A) The mass of the substance	(B) The change in temperature of the substance
(C) The type of hot plate used	(D) The size of the room

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Question 15: Why does an iceberg at 0°C have much more total thermal energy than a boiling cup of tea at 100°C?

(A) 0°C is a higher temperature than 100°C	(B) Ice molecules move faster than boiling water molecules
(C) The iceberg has a vastly greater mass (billions more moving water molecules) than the cup of tea	(D) Boiling water has zero thermal energy

Question 16: A student heats four blocks made of the same metal (50 g, 100 g, 150 g, and 200 g) with the same amount of thermal energy. Which block will have the GREATEST increase in temperature?

(A) The 50 g block	(B) The 100 g block
(C) The 150 g block	(D) The 200 g block

Question 17: A student heats four blocks made of the same metal (50 g, 100 g, 150 g, and 200 g) with the same amount of thermal energy. Which block will have the SMALLEST increase in temperature?

(A) The 50 g block	(B) The 100 g block
(C) The 150 g block	(D) The 200 g block

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Q12 : Module 2: The Water Cycle

Lesson 1: Water in the Atmosphere

Explain real-life examples of evaporation and condensation.

(Pages 109 - 111 , 113 - 115)

Multiple Choice Questions - MCQ

Structured Concept Explanation (What Influences Why and How Quickly Water Disappears? · Page 109-111 (and Pages 113-115)):

In daily life, liquid water disappears from puddles, wet clothes, and wet paper towels through evaporation. When sunlight shines on a puddle, water molecules at the surface absorb thermal energy, vibrate faster, break free from the attraction of neighboring molecules, and rise into the air as invisible water vapor. A wet paper towel placed in direct sunlight (Towel A) dries much faster than one in the shade (Towel B) because higher thermal energy increases the rate of evaporation. Conversely, when warm, moist air touches a cold surface or cools in the atmosphere, the water vapor loses thermal energy, slows down, and turns back into liquid droplets through condensation. Real-life examples of condensation include water droplets forming on the outside of a cold glass, morning dew on grass and spider webs, seeing your breath on a cold day, a bathroom mirror fogging up after a hot shower, and clouds forming high in the troposphere.

Key Ideas from the Student Book:

- In Lab "Into Thin Air" (p. 110), Paper Towel A in direct sunlight evaporates water faster than Paper Towel B in the shade because sunlight provides more thermal energy.
- Water vapor itself is a completely invisible gas; the clouds, fog, and mist we see are tiny liquid water droplets (or ice crystals) formed AFTER condensation.
- Factors that speed up evaporation include higher temperature (more sunlight), larger surface area (spread-out puddle), and wind.

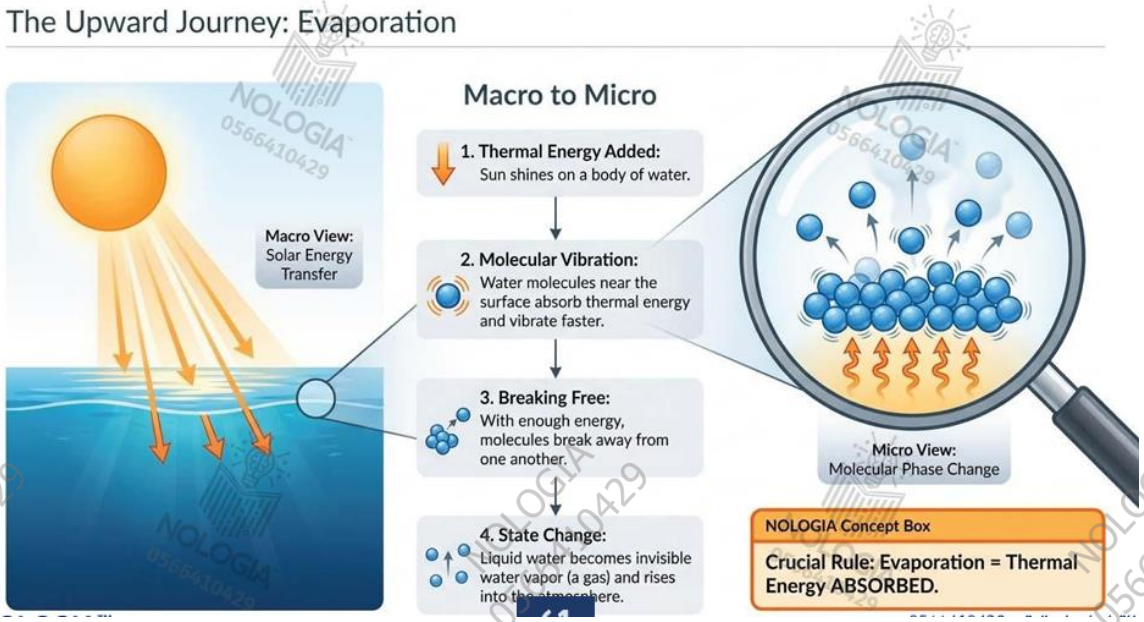
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Process	How It Happens in Real Life	Real-Life Everyday Examples
Evaporation (Liquid → Gas)	Sunlight/heat warms surface water molecules; they gain kinetic energy and escape into air as invisible water vapor	Puddle drying after rain; wet clothes/paper towel drying in the sun; sweat drying on skin
Condensation (Gas → Liquid)	Warm water vapor in air cools, loses thermal energy, slows down, and forms liquid droplets	Drops on outside of a cold cup; morning dew on spider webs/grass; fogged bathroom mirror; seeing breath on a cold day; clouds forming

Remember:

✓ Real-life Evaporation = Puddles disappearing, wet laundry drying in sunlight, sweat cooling skin.

✓ Real-life Condensation = Dew on grass/spider webs, water beads on a cold drink glass, fogged mirror, clouds forming.





Questions :

Question 1: Make a claim about what affects the rate at which water disappears. What evidence from the lab supports your claim?

(A) Claim: Greater thermal energy (sunlight/heat) increases the rate of evaporation. Evidence: The water drop on Paper Towel A in direct sunlight decreased in diameter and dried much faster than on Paper Towel B in the shade.	(B) Claim: Shade increases evaporation. Evidence: Paper Towel B dried faster than Paper Towel A.
(C) Claim: Temperature has no effect on evaporation. Evidence: Both paper towels dried at the exact same second.	(D) Claim: Water disappears by freezing into solid crystals in the sun.

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Question 2: on the figure above, model the process that changes liquid water to water vapor. Label the transfer of energy that takes place during this process. Why do bodies of water disappear?

(A) Thermal energy from the Sun is absorbed by liquid water at the surface, causing water molecules to move faster and escape into the air as invisible water vapor gas (evaporation).	(B) Thermal energy is released from the puddle into space, causing water vapor to condense into rock.
(C) Sunlight destroys water molecules so they cease to exist.	(D) Gravity pulls liquid water molecules straight up into the clouds without changing state.

Question 3: What happens to a rainwater puddle on a sidewalk on a sunny afternoon?

(A) It freezes into a glacier	(B) It absorbs thermal energy from the Sun and evaporates into invisible water vapor
(C) It condenses into solid rock	(D) Its molecules lose kinetic energy and stop moving

Question 4: Where do the water droplets that appear on the outside of a cold glass of iced water come from?

(A) Liquid water leaks directly through the solid glass walls	(B) Ice inside the glass evaporates through the glass
(C) Water vapor in the surrounding warm air cools and condenses on the cold glass surface	(D) The glass melts into liquid water

Question 5: Early in the morning, tiny water droplets glisten on a spider web . Which process formed these droplets?

(A) Condensation	(B) Evaporation
(C) Transpiration	(D) Sublimation

Question 6: Why can you "see your breath" as a white mist when you exhale outside on a cold winter day?

(A) Your lungs breathe out solid smoke particles	(B) Cold air evaporates the skin on your lips
(C) Oxygen gas turns into a solid crystal	(D) Warm water vapor in your breath cools rapidly in the cold air and condenses into tiny liquid droplets

Question 7: After taking a hot shower, the bathroom mirror is covered in fog (tiny water droplets). Why did this happen?

(A) The mirror glass evaporated into the air	(B) Warm water vapor from the shower touched the cooler mirror, lost thermal energy, and condensed
(C) Cold water from the mirror boiled into steam	(D) Transpiration occurred inside the mirror

Question 8: Which of the following is an example of EVAPORATION in daily life?

(A) Dew forming on a car windshield overnight	(B) Clouds forming high in the sky
(C) Wet clothes hanging on a clothesline drying in the sun	(D) Frost forming inside a freezer

Question 9: Which of the following is an example of CONDENSATION in nature?

(A) Water vapor rising into cooler air and forming clouds	(B) Ocean water turning into water vapor on a sunny day
(C) Snow melting on a mountain in spring	(D) A puddle drying up on a playground

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(C) Snow melting on a mountain in spring	(D) A puddle drying up on a playground

Question 10: Can you see water vapor gas in the air?

(A) Yes, water vapor is bright blue	(B) Yes, every cloud is pure gas with no liquid droplets
(C) Yes, water vapor looks like solid ice cubes	(D) No, water vapor is an invisible gas; we only see water after it condenses into liquid droplets or ice crystals

Question 11: Which part of a liquid puddle evaporates first when heated by the Sun?

(A) Only the water molecules touching the bottom soil	(B) The water molecules at the top surface of the puddle
(C) Only the frozen ice at the center	(D) All molecules from top to bottom boil at 100°C simultaneously

Question 12: Why do water molecules rise into the air after evaporating from a puddle?

(A) Water vapor is heavier than solid rock	(B) Gravity pushes water vapor upward
(C) Warm air containing water vapor is less dense and rises by convection	(D) Magnetic forces pull water molecules into space

Question 13: What happens to warm, moist air as it rises higher into the troposphere?

(A) It cools, loses thermal energy, and its water vapor condenses around tiny particles to form clouds	(B) It gets hotter and hotter until it boils
(C) It turns directly into solid granite rock	(D) It loses all of its mass

Question 14: From which Earth reservoir does the GREATEST amount of water evaporate into the atmosphere each year?

(A) Small backyard swimming pools	(B) Deep underground caves
(C) Frozen polar glaciers	(D) The oceans

Question 15: If 50 mL of water is poured into a tall narrow tube and another 50 mL is spread out in a wide flat tray in the sun, which one evaporates faster?

(A) The water in the tall narrow tube	(B) The water in the wide flat tray, because a larger surface area is exposed to sunlight and air
(C) Both evaporate at the exact same speed	(D) Neither will evaporate below 100°C

Question 16: How does a person's eyeglasses fog up when walking from cold outdoor air into a warm, humid building?

(A) The glass lenses evaporate into gas	(B) Cold air freezes the indoor air into snow
(C) Water vapor in the warm indoor air condenses on the cold eyeglass lenses	(D) Sunlight melts the eyeglass frames

Question 17: Which statement correctly summarizes the energy transfer during evaporation and condensation?

(A) Evaporation absorbs thermal energy from the surroundings, while condensation releases thermal energy	(B) Evaporation releases thermal energy, while condensation absorbs thermal energy
(C) Both processes absorb thermal energy	(D) Both processes release thermal energy

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Q13 : Module 2: The Water Cycle

Lesson 2: Water on Earth's Surface

Describe how gravity moves water downhill.

(Page 135)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Three-Dimensional Thinking · Page)

Gravity—the attractive force toward Earth's center—is a primary driving force of the water cycle alongside thermal energy from the Sun. Gravity pulls condensed water droplets and ice crystals down from clouds as precipitation (rain, snow, sleet, hail). Once water reaches Earth's surface, gravity causes surface water to flow downhill from higher elevations to lower elevations as runoff in streams and rivers toward lakes and oceans. Gravity also pulls surface water downward through soil pores and rock cracks into the ground (infiltration) and moves groundwater slowly downhill through permeable rock toward the ocean. Even massive solid glaciers slowly flow downhill under the pull of gravity.

Key Ideas from the Student Book:

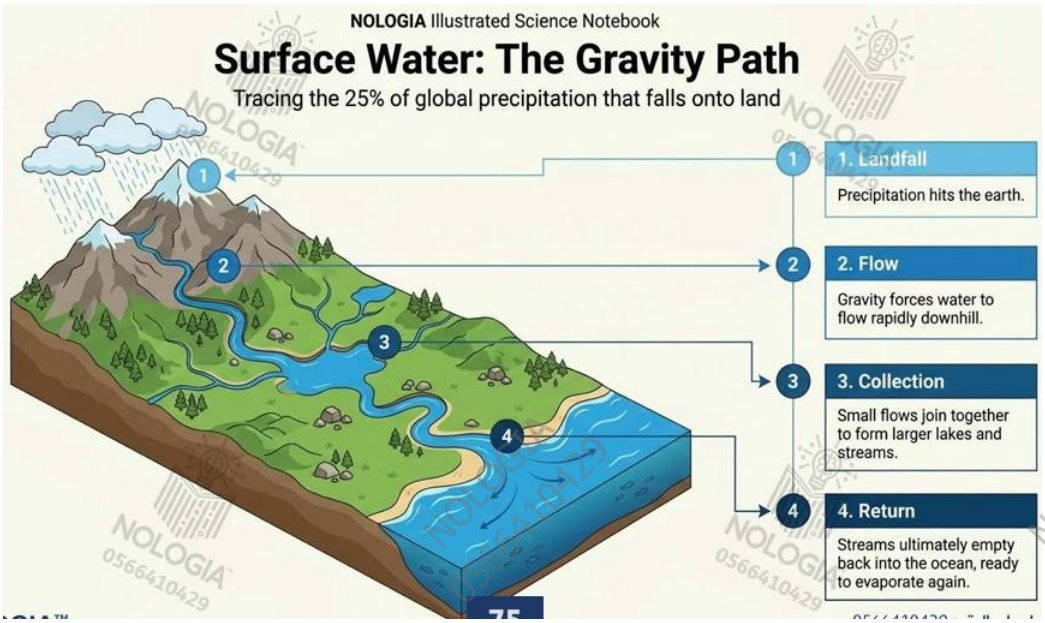
- In Question 2 on page 135, four friends walk along a stream: Selma is correct because she states that "Gravity causes water in the stream to move downhill."
- Water never flows uphill naturally on Earth's surface; it always flows from higher elevation to lower elevation due to gravity.
- Together, solar energy (which lifts water vapor into the air by evaporation) and gravity (which pulls water back down) keep water cycling through Earth's systems.

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Water Cycle Process	How Gravity Moves the Water	Direction of Movement
Precipitation	Pulls heavy water droplets or ice crystals down from clouds	Downward from atmosphere to Earth's surface
Surface Runoff (Streams & Rivers)	Moves liquid water over land from mountains/hills toward oceans	Downhill from higher elevation to lower elevation
Infiltration & Groundwater Flow	Pulls water down through soil and moves it through aquifers	Downward into ground and downhill toward oceans
Glacier Flow	Pulls massive sheets of compressed ice down mountain valleys	Slowly downhill toward lower elevations or the sea

Remember:

✓ Gravity pulls water DOWN: causes precipitation, downhill stream/river runoff, infiltration into groundwater, and glacier flow.



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Questions :



Question 1: Four friends are walking along the bank of a stream. They each have differing opinions of why the stream moves along Earth's surface. 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.

Question 2: Which pathway of processes would explain how a water molecule from the stream could end up in an ice sheet?

(A) evaporation, condensation, crystallization, precipitation	(B) evaporation, respiration, crystallization, transpiration
(C) evaporation, crystallization, precipitation, condensation	(D) evaporation, transpiration, condensation, crystallization

Question 3: In which direction does gravity move liquid water on Earth's surface?

(A) Downhill, from higher elevations to lower elevations	(B) Uphill, from the ocean to the tops of mountains
(C) Straight upward into the stratosphere	(D) Only from west to east regardless of slope

Question 4: What is water that flows downhill over the land surface without soaking into the ground called?

(A) Transpiration	(B) Condensation
(C) Surface runoff	(D) Sublimation

Question 5: How does gravity affect rainwater that lands on permeable soil?

(A) Gravity pushes the water immediately back into the clouds	(B) Gravity turns the soil into ice crystals
(C) Gravity prevents water from entering the ground	(D) Gravity pulls the water downward through spaces between soil and rock particles to become groundwater

Question 6: Once water is underground as groundwater, does it stay completely still or move?

(A) It stays frozen in one spot forever	(B) Gravity causes groundwater to flow slowly downhill from higher to lower elevations toward lakes and oceans
(C) It flows rapidly uphill to mountain peaks	(D) It evaporates directly through solid granite rock

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Question 7: What causes massive glaciers on mountains to slowly move downhill over time?

(A) The pull of gravity on the heavy mass of ice	(B) Ocean waves pushing the mountain
(C) Transpiration from pine trees	(D) Solar wind from outer space

Question 8: Where do most rivers and streams eventually empty their water due to gravity?

(A) Into the tops of clouds	(B) Onto the highest mountain peaks
(C) Into the ocean (the lowest elevation reservoir)	(D) Into outer space

Question 9: How does the steepness of a hill affect the speed of water flowing downhill?

(A) Water flows slower down a steeper slope	(B) Water flows faster down a steeper slope than down a gentle slope
(C) Slope has no effect on water speed	(D) Water flows uphill on steep slopes

Question 10: When raindrops in a cloud become too large and heavy for updrafts of air to hold them up, what happens?

(A) They float higher into outer space	(B) They turn into sunlight
(C) They stay suspended forever	(D) Gravity pulls them down to Earth as precipitation

Question 11: Which two main factors drive the entire water cycle on Earth?

(A) Thermal energy from the Sun and gravity	(B) Magnetism and electricity
(C) Tectonic plates and volcanoes	(D) Sound waves and friction

Question 12: Which water-cycle processes are driven directly by GRAVITY rather than solar heating?

(A) Evaporation and transpiration	(B) Evaporation and boiling
(C) Precipitation, surface runoff, and infiltration	(D) Photosynthesis and cellular respiration

Question 13: What happens to snow that accumulates in thick layers on high mountains over many years?

(A) It floats upward into the clouds as solid blocks	(B) It compresses into glacial ice and slowly flows downhill under gravity
(C) It turns into hot magma	(D) It never moves or melts

Question 14: If rain falls on a steep paved parking lot versus a flat grassy field, where will more rapid downhill runoff occur?

(A) On the steep paved parking lot, because water cannot soak into pavement and gravity pulls it rapidly down the slope	(B) On the flat grassy field
(C) Runoff will be zero on both surfaces	(D) Water will flow uphill on the paved lot

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Question 15: How do waterfalls form along a river's path?

(A) Evaporation lifts river water over a cliff	(B) Condensation freezes the river bottom
(C) Wind blows the river backward	(D) Gravity pulls river water straight down over a steep cliff or rock ledge

Question 16: Without gravity, what would happen to condensed water droplets in clouds?

(A) They would fall ten times faster as heavy rain	(B) Rivers would flow downhill even faster
(C) They would not fall to Earth as precipitation and would not flow downhill in rivers	(D) Groundwater would sink deeper into Earth's core

Question 17: What force pulls rain, snow, sleet, and hail down from clouds to Earth's surface?

(A) Solar radiation	(B) Gravity
(C) Evaporation	(D) Transpiration

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Q14 : Module 2: The Water Cycle

Lesson 2: Water on Earth's Surface

Identify/classify water reservoirs such as oceans, rivers, lakes, groundwater and glaciers.

(Page 132)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Collect Evidence · Page 132)

Water on Earth is stored in storage areas called reservoirs. About 97% of all water on Earth is saltwater stored in the oceans (the largest reservoir). Only about 3% of Earth's water is freshwater. Most of Earth's freshwater (~68-79%) is frozen in glaciers and ice caps at the poles and on high mountains. The second largest freshwater reservoir is groundwater, which is liquid water stored underground in the pores and cracks of permeable soil and rock (called aquifers). Above the water table is the unsaturated zone (pores contain both air and water), and below the water table is the saturated zone (pores are completely filled with water). Only a tiny fraction (~1%) of freshwater is surface water found in lakes, rivers, streams, soil moisture, and the atmosphere.

Key Ideas from the Student Book:

- Oceans hold ~97% of Earth's total water (saltwater), while freshwater makes up only ~3%.
- Most freshwater is locked in solid ice (glaciers and polar ice caps), NOT in lakes or rivers.
- Groundwater collects in permeable rock/sediment layers called aquifers; the top of the saturated zone is called the water table. In deserts, where the water table meets the surface, an oasis forms.

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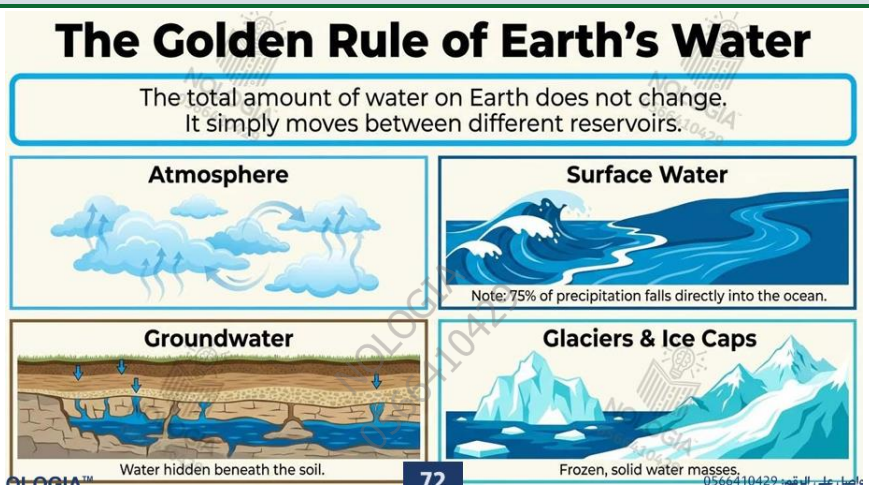
Water Reservoir	Water Type & State	Share of Earth's Water & Key Features
Oceans	Saltwater (Liquid)	~97% of all Earth's water; largest reservoir on Earth
Glaciers & Ice Caps	Freshwater (Solid Ice)	Largest freshwater reservoir (~68-79% of freshwater); forms from compressed snow
Groundwater (Aquifers)	Freshwater (Liquid)	Second largest freshwater reservoir; stored in permeable rock/sediment below the water table
Lakes, Rivers & Streams	Freshwater (mostly Liquid)	Small fraction (~1%) of freshwater on Earth's land surface
Atmosphere	Freshwater (Gas vapor & Liquid/Ice clouds)	Tiny fraction; transports water globally via winds

Remember:

✓ Largest TOTAL water reservoir = Oceans (~97%, saltwater).

✓ Largest FRESHWATER reservoir = Glaciers and Ice Caps (solid ice).

✓ Second largest FRESHWATER reservoir = Groundwater (in permeable rock / saturated zone below the water table).



Questions :



Question 1: How does water become groundwater and where else is water stored?

(A) Surface water seeps downward through pores and cracks in permeable soil and rock into the saturated zone (aquifers) to become groundwater; water is also stored in oceans (~97%), glaciers and ice caps, lakes, rivers, and the atmosphere.	(B) Groundwater forms only when ocean salt crystallizes on desert sand dunes.
(C) Water cannot pass through permeable rock, so 99% of Earth's water is stored in rivers.	(D) Groundwater is stored above the water table in the dry air.

Question 2: What is a "reservoir" in the water cycle?

(A) A type of thermometer used to measure ocean heat	(B) A storage area on or below Earth's surface (or in the atmosphere) where water is held
(C) A wind belt near the equator	(D) A metal conductor used in kitchens

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Question 3: Which reservoir holds about 97% of all water on Earth?

(A) The oceans	(B) Rivers and streams
(C) Groundwater aquifers	(D) Clouds in the atmosphere

Question 4: Where is the LARGEST amount of Earth's FRESHWATER stored?

(A) In rivers and streams	(B) In the atmosphere as water vapor
(C) In glaciers and polar ice caps	(D) In freshwater lakes

Question 5: Where is the SECOND largest amount of Earth's freshwater stored?

(A) In clouds	(B) In rivers
(C) In living plants and animals	(D) Underground as groundwater

Question 6: What is "groundwater"?

(A) Saltwater at the bottom of the ocean	(B) Water that is stored underground in the cracks and pore spaces of soil, sand, and rock
(C) Frozen snow on mountain peaks	(D) Rainwater sitting on top of a paved road

Question 7: What do we call soil or rock that has connected pore spaces that allow water to pass through it easily?

(A) Permeable material	(B) Impermeable material
(C) Crystalline ice	(D) Condensation nuclei

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Question 8: In the groundwater diagram (Page 132), what is the underground region where all pore spaces in the rock and soil are completely filled with water?

(A) The unsaturated zone	(B) The troposphere
(C) The saturated zone	(D) The glacier zone

Question 9: What is the upper boundary (top surface) of the saturated zone underground called?

(A) The ocean floor	(B) The water table
(C) The continental divide	(D) The jet stream

Question 10: What is an "aquifer"?

(A) A cloud that produces hail	(B) A frozen river in Antarctica
(C) A wall built across a river	(D) An underground layer of permeable rock or sediment that holds and transmits groundwater

Question 11: How does a desert oasis (such as Al Ain Oasis in the UAE) form?

(A) Groundwater from an underground aquifer reaches the land surface where the water table intersects a low area	(B) Ocean waves flood the middle of the desert every afternoon
(C) Glaciers melt on sand dunes every summer	(D) Saltwater evaporates and leaves fresh ice behind

Question 12: How do glaciers form on Earth's surface?

(A) Ocean water freezes instantly during a hurricane	(B) Groundwater boils and freezes in the desert
(C) Layers of snow build up year after year without melting completely and are compressed by weight into thick masses of ice	(D) Dew on grass freezes for one morning

Question 13: Approximately what percentage of all water on Earth is freshwater?

(A) About 3%	(B) About 50%
(C) About 75%	(D) About 97%

Question 14: What is the difference between the unsaturated zone and the saturated zone underground?

(A) The unsaturated zone is below the saturated zone	(B) Pores in the unsaturated zone contain both air and water, while pores in the saturated zone are completely filled with water
(C) The saturated zone contains only dry air	(D) The unsaturated zone is made of solid ice

Question 15: Which of the following is classified as a SURFACE freshwater reservoir?

(A) The Pacific Ocean	(B) Deep confined aquifers
(C) The Arabian Gulf	(D) Lakes and rivers

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Q15 : Module 3: Weather and Climate

Lesson 1: Solar Energy on Earth

Describe how unequal heating moves air & water.

(Page 159)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Three-Dimensional Thinking · Page 159)

Different materials on Earth absorb and release thermal energy at different rates because they have different specific heats. Water has a very high specific heat—about 6 times higher than the specific heat of land (sand/soil)—while air has an even lower specific heat than both land and water. Because of this: (1) During a sunny day at the beach, sand (land) heats up much faster than ocean water, and the air above the sand heats up fastest of all; the warm, less dense air over the land rises (low pressure) and cooler, denser air from over the water blows inland to replace it (a sea breeze). (2) At night, sand and air release thermal energy and cool down much faster than the ocean water, which stays relatively warm; warm air rises over the ocean and cool air blows from the land toward the sea (a land breeze). Globally, unequal solar heating between the warm equator and cold poles creates temperature and density differences that drive atmospheric winds and ocean currents.

Key Ideas from the Student Book:

- Specific heat of water is ~6 times greater than land (sand/soil), so water requires 6 times more thermal energy to raise its temperature by 1°C.
- In Three-Dimensional Thinking , air has the lowest specific heat, followed by sand (land), while water has the highest specific heat.
- Unequal heating creates temperature differences → density and pressure differences → convection currents that move air (wind) and water (ocean currents).

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Material at the Beach	Specific Heat Comparison	Daytime Behavior (Sunlight)	Nighttime Behavior (No Sunlight)
Water (Ocean)	Highest specific heat (~6× higher than sand)	Absorbs heat slowly → stays cool during the day	Releases heat slowly → stays warmer than land at night
Sand (Land)	Low specific heat (~6× lower than water)	Absorbs heat quickly → becomes very hot during the day	Releases heat quickly → becomes cool at night
Air (Atmosphere)	Lowest specific heat of the three	Warms up and cools down fastest via conduction/convection with the surface below it	Moves from cooler high-pressure areas to warmer low-pressure areas (wind)

Remember:

✓ Specific Heat Order (Highest to Lowest): Water > Sand (Land) > Air.

✓ Heating & Cooling Speed (Fastest to Slowest): Air > Sand (Land) > Water.

✓ Unequal heating drives convection currents in both the atmosphere (winds) and oceans (currents).

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Different surfaces absorb and release thermal energy at different rates.





Specific Heat **Specific Heat**

The amount of heat needed to raise the temperature of 1 kg of a material by 1°C.

The specific heat of water is about six times higher than the specific heat of land.

Comparison Matrix: Land vs. Water Dynamics

Characteristic	Land (Soil/Sand)	Water (Oceans/Lakes)
Specific Heat Level	Low Specific Heat	High Specific Heat (6x higher)
Heating Speed (Day/Summer)	Absorbs thermal energy relatively quickly	Absorbs thermal energy much more slowly
Cooling Speed (Night/Winter)	Releases thermal energy quickly	Releases thermal energy slowly

Because water requires so much more energy to change temperature, oceans act as massive global temperature regulators compared to continents.

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Questions :

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.



Question 1: 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.

2. Explain why the flow of energy between air and sand is different than that between air and water from day to night."

(A) Sand and air have lower specific heats and warm up/cool down much faster than water (which has ~6× higher specific heat than sand); during the day warm air rises over the hot sand (sea breeze), and at night warm air rises over the warmer ocean water (land breeze).	(B) Water absorbs thermal energy fastest during the day and becomes hotter than the sand.
(C) Air has the highest specific heat, while ocean water has the lowest specific heat.	(D) Thermal energy flows from the cold ocean water into the hot sand during a sunny afternoon.

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Question 2: How does the specific heat of liquid water compare to the specific heat of land (sand or soil)?

(A) The specific heat of water is 6 times lower than land	(B) Water and land have the exact same specific heat
(C) The specific heat of water is about 6 times higher than the specific heat of land	(D) Water has zero specific heat

Question 3: On a hot, sunny afternoon at the beach, why does the dry sand feel burning hot to your feet while the ocean water feels cool and refreshing?

(A) The Sun only shines on the sand and not on the water	(B) Sand has a much lower specific heat than water, so its temperature rises much faster with the same sunlight
(C) Water is a metal conductor with low specific heat	(D) Ocean water reflects 100% of solar energy

Question 4: If you walk on the same beach late at night, which will feel warmer—the sand or the ocean water—and why?

(A) The ocean water will feel warmer because water releases thermal energy much more slowly than sand	(B) The sand will feel hotter because sand stores heat longer than water
(C) Both will be frozen solid at 0°C	(D) Sunlight heats the ocean from below at night

Question 5: Among water, sand (land), and air, which material has the LOWEST specific heat (and therefore changes temperature fastest)?

(A) Ocean water	(B) Freshwater
(C) Wet mud	(D) Air

Question 6: Which list correctly ranks the three beach materials from HIGHEST specific heat to LOWEST specific heat?

(A) Air → Sand (land) → Water	(B) Water → Sand (land) → Air
(C) Sand (land) → Water → Air	(D) Water → Air → Sand (land)

Question 7: During the day at the beach, how does unequal heating of land and water create a sea breeze?

(A) Warm air rises over the hot sand, and cooler, denser air from over the ocean blows inland to replace it	(B) Warm air rises over the cold ocean, and air blows from land to sea
(C) Both land air and ocean air sink and stop moving	(D) Ocean waves push air uphill by gravity

Question 8: At night at the beach, how does unequal cooling of land and water create a land breeze?

(A) Cool air rises over the land and blows inland	(B) Sunlight heats the sand more than the ocean at midnight
(C) Warm air rises over the warmer ocean water, and cooler air from the land blows out toward the ocean	(D) All wind stops at night because there is no gravity

Question 9: Why does solar energy penetrate deeper into ocean water than into solid land?

(A) Land is transparent and water is opaque	(B) Solid rock mixes rapidly by convection currents
(C) Sunlight cannot enter liquid water at all	(D) Water is transparent and fluid (allowing light to penetrate and mix by convection), while land is opaque and heats only at the top surface

Question 10: How does unequal solar heating between the equator and the poles cause ocean water to move in deep density currents?

(A) Cold polar water boils and rises to the surface	(B) Warm equatorial water moves toward the poles, where it cools, becomes denser (and saltier as ice forms), and sinks
(C) Ocean water only moves when pushed by boats	(D) Water at the equator is frozen solid

Question 11: Why do coastal cities (near the ocean) usually have milder temperatures (cooler summers and warmer winters) than inland cities at the same latitude?

(A) Ocean water's high specific heat causes it to warm and cool slowly, moderating the air temperature of nearby land	(B) Inland soil has a higher specific heat than ocean water
(C) Coastal cities receive no sunlight in summer	(D) Inland cities are closer to the Sun

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Question 12: In the soil vs. water lab, after the heat lamp is turned OFF for 10 minutes, which substance cools down faster?

(A) The soil cools down faster than the water	(B) The water cools down faster than the soil
(C) Both stay at their peak temperature forever	(D) The water freezes while the soil boils

Question 13: What happens to the density and pressure of air when it is heated by warm land?

(A) Its particles pack closer together, its density increases, and it sinks	(B) Its particles spread apart, its density decreases, and it rises, creating an area of low pressure
(C) Its density and pressure both double	(D) It turns into liquid water immediately

Question 14: What happens to the density and pressure of air when it is cooled over cold water or ice?

(A) Its particles spread far apart and rise rapidly	(B) Its density drops to zero
(C) It creates a low-pressure storm center	(D) Its particles move closer together, its density increases, and it sinks, creating an area of high pressure

Question 15: If Earth's surface were heated equally everywhere, what would happen to global winds?

(A) Global winds would blow ten times faster	(B) Hurricanes would cover the entire planet
(C) There would be no temperature or pressure differences to drive global convection winds	(D) Trade winds would blow straight up into space

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Q16 : Module 1: Energy and Matter

Lesson 3: Thermal Energy Transfers

Interpret diagrams showing heat transfer.

(Page 58 - 61)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Where do thermal energy go? · Page 58-61):

In the investigation "Transferring Temperature / Where does thermal energy go?" (Pages 58-61), a small beaker containing hot water is placed inside a large beaker containing cold water, with thermometers in each. Thermal energy transfers from the hot water in the small beaker (source) through the glass wall into the cold water in the large beaker (receiver), and also into the surrounding room air, because the open beakers form an open system (a system that exchanges both matter and energy with its surroundings). By contrast, a closed system (or thermally insulated system) restricts matter and energy from escaping to the surroundings. On the particle diagram (Page 61), fast-moving hot water particles collide with the glass particles, which vibrate faster and collide with the cooler water and air particles on the outside, transferring thermal energy by conduction until all parts reach thermal equilibrium.

Key Ideas from the Student Book:

- In the two-beaker diagram (Page 58), heat arrows point OUT from the hot inner beaker into the cold outer beaker and into the surrounding air.
- An open system allows energy and matter (such as evaporating water vapor) to escape into the environment; a closed/insulated system keeps energy inside.
- After enough time passes, both the water in the small beaker, the water in the large beaker, and the room air reach the same temperature (thermal equilibrium).

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Part of Beaker System	Initial State	Direction of Heat Transfer & Particle Behavior
Hot Water in Small Inner Beaker	High temperature; fast-moving particles	Source object: loses thermal energy; temperature decreases over time
Glass Beaker Wall	Between hot water and cold water	Transfers thermal energy outward by conduction (particle collisions)
Cold Water in Large Outer Beaker	Low temperature; slow-moving particles	Receiver object: gains thermal energy from inner beaker; temperature increases
Surrounding Room Air (Open System)	Cooler than the hot water	Absorbs escaped thermal energy (and water vapor) from the open top

Remember:

✓ Hot inner beaker → Cold outer beaker + Surrounding air (Heat arrows ALWAYS point from hot to cold).

✓ Hot water temperature goes DOWN; Cold water temperature goes UP until they meet at thermal equilibrium.

Where does thermal energy go?

Have you ever forgotten about food that you had heated up in the microwave? You might have needed to heat it up again because it had become cold. The microwave increased the thermal energy of the food by increasing the temperature of the food. Why did the food become cold after you forgot about it?

Want more information?
Go online to read more about thermal energy transfers.



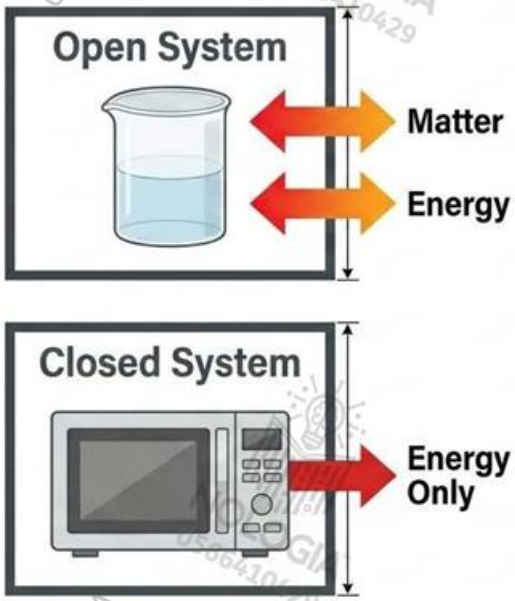
Why did it become cold?

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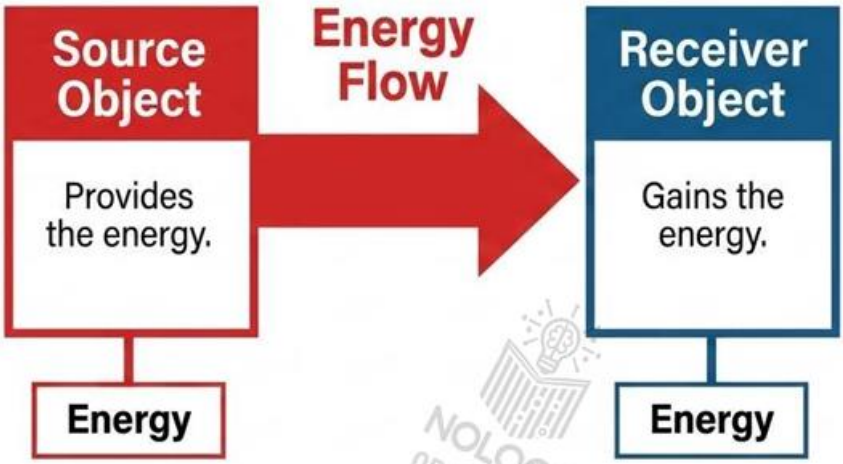
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Defining the System

Types of Systems



The Energy Flow Model



Questions :

Question 1: Why did the food heated in the microwave (or hot toast) become cold after you forgot about it?

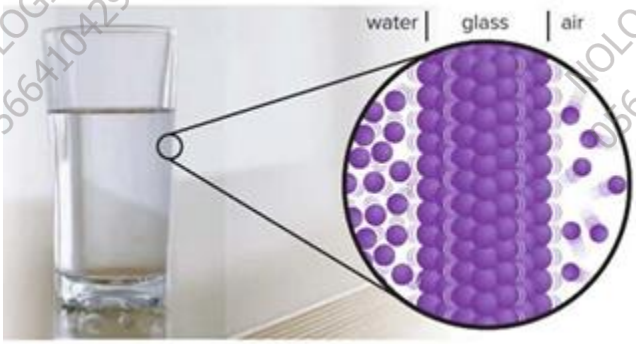
(A) Thermal energy transferred from the warmer food (source object) into the cooler surrounding air and plate (receiver objects) until they reached the same temperature (thermal equilibrium).	(B) Coldness flowed out of the room air into the food and destroyed its mass.
(C) The food absorbed thermal energy from the cooler room air.	(D) Thermal energy vanished from existence without warming the air.

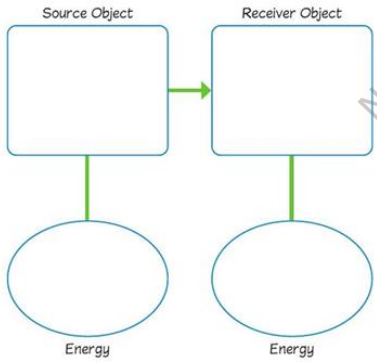
Question 2: 1. Identify any patterns in the data.

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

(A) Pattern: The hot water temperature in the small beaker decreased while the cold water temperature in the large beaker increased. Measuring the classroom air temperature was important because the uncovered beakers form an open system that also transfers thermal energy to the surrounding air.	(B) Pattern: Both beakers increased in temperature above 100°C because the classroom air is a closed system.
(C) Pattern: The cold water got colder and the hot water got hotter.	(D) Classroom air temperature was measured only to check air pressure.

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Question 3: In the particle diagram (water | glass | air) and energy flow diagram, how is thermal energy transferred from the hot water inside the beaker to the outside?

(A) Fast-moving hot water particles (source, kinetic energy decreases) collide with the solid glass particles, which transfer kinetic/thermal energy by conduction to the cooler water and air particles outside (receiver, kinetic energy increases).	(B) Water molecules pass straight through the solid glass wall into the air.
(C) Slow-moving air particles transfer cold energy inward to speed up the hot water particles.	(D) No particle collisions occur between the water, glass, and air.

Question 4:what happens to the temperature reading on the thermometer in the SMALL (hot water) beaker over 15 minutes?

(A) It increases above 100°C	(B) It decreases steadily as thermal energy leaves the hot water
(C) It stays at 70°C forever	(D) It drops below 0°C

Question 5: In the two-beaker experiment, what happens to the temperature reading on the thermometer in the LARGE (cold water) beaker as it absorbs heat from the inner beaker?

(A) It increases as it absorbs thermal energy from the hot water	(B) It decreases to 0°C
(C) It remains unchanged	(D) It rises higher than the initial temperature of the hot water

Question 6: Why does some thermal energy escape from the beakers into the classroom during the experiment?

(A) Because glass is a perfect thermal insulator	(B) Because the classroom is at 500°C
(C) Because the uncovered beakers form an open system that exchanges thermal energy and matter with the surrounding air	(D) Because thermal energy is destroyed by light

Question 7: What is the difference between an open system and a closed system?

(A) An open system has a tight lid, while a closed system has no lid	(B) Neither system can transfer energy
(C) A closed system destroys energy, while an open system creates energy	(D) An open system exchanges both matter and energy with its surroundings, while a closed system does not exchange matter with its surroundings

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Question 8: In the diagram on Page 61, why are the particles in the "Glass" column packed tightly in rows while the particles in the "Air" column are far apart?

(A) Glass is a gas and air is a solid	(B) Glass is a solid with tightly packed particles, whereas air is a gas with widely spaced particles
(C) Air has a higher density than glass	(D) Glass particles have no mass

Question 9: If you draw arrows to represent heat flow between a cup of 80°C tea and the 20°C air around it, which way must the arrows point?

(A) Pointing inward from the 20°C air into the 80°C tea	(B) Pointing in a circle inside the air only
(C) Pointing outward from the 80°C tea into the 20°C air and table	(D) No arrows should be drawn because heat does not move

Question 10: If you draw arrows to represent heat flow between a glass of 2°C ice water and the 25°C room air around it, which way must the arrows point?

(A) Pointing inward from the 25°C room air into the 2°C ice water	(B) Pointing outward from the 2°C ice water into the 25°C room air
(C) Pointing downward due to gravity only	(D) Pointing from the ice cube into the water

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Question 11: If the small beaker starts at 60°C and the large beaker starts at 20°C, which of the following could be their final equilibrium temperature after 20 minutes?

(A) 80°C (higher than both starting temperatures)	(B) 32°C (a temperature between 20°C and 60°C)
(C) 5°C (lower than both starting temperatures)	(D) 100°C

Question 12: How could a student modify the two-beaker experiment to reduce the loss of thermal energy to the classroom air?

(A) Use a wider open metal pan with no lid	(B) Blow a fan across the top of the beakers
(C) Replace the glass beakers with thin copper cups	(D) Place an insulated lid over the beakers and wrap the outer beaker in foam insulation

Question 13: On a temperature-versus-time graph of the two-beaker experiment, how do the two lines (hot water and cold water) look as they reach thermal equilibrium?

(A) Both lines slope sharply upward forever	(B) The hot-water line goes up and the cold-water line goes down
(C) The hot-water line slopes down and the cold-water line slopes up until the two lines meet and flatten at the same temperature	(D) Both lines remain horizontal without meeting

Question 14: During the heat transfer between the hot water and the cold water, is total energy destroyed when the hot water cools down?

(A) No, energy is conserved; the thermal energy lost by the hot water is gained by the cold water, beakers, and air	(B) Yes, the thermal energy vanishes completely from the universe
(C) Yes, energy is destroyed whenever water cools	(D) No, because the hot water actually gains more energy

Question 15: In a particle diagram showing two objects in contact, Object 1 has particles with 3 motion lines and Object 2 has particles with 1 motion line. After they reach thermal equilibrium, how many motion lines will particles in both objects have?

(A) Object 1 will have 4 motion lines and Object 2 will have 0	(B) Both objects will have 2 motion lines (the same intermediate average kinetic energy)
(C) Object 1 will have 1 motion line and Object 2 will have 3	(D) Both objects will have 0 motion lines

Question 16: Which type of heat transfer is responsible for warm air rising above the open top of the hot beaker?

(A) Conduction	(B) Convection
(C) Crystallization	(D) Infiltration

Q17 : Module 2: The Water Cycle

Lesson 1: Water in the Atmosphere

Interpret diagrams or models of evaporation, condensation and crystallization.

(Page 119)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Three-Dimensional Thinking · Page 119 (Question 3, Supported by Page 116)):

In the atmosphere, water changes state when thermal energy is absorbed or released. During evaporation (liquid to gas), water molecules absorb thermal energy from sunlight and move faster. During condensation (gas to liquid), water vapor cools in the atmosphere and releases thermal energy as liquid cloud droplets form. If the temperature in the clouds drops below 0°C (the freezing point of water), liquid water droplets lose even more thermal energy and freeze into solid six-sided ice crystals (snowflakes) through crystallization. Therefore, when water changes state from a liquid to a solid (as seen in the snowy forest on Page 119), thermal energy is released into the surrounding air.

Key Ideas from the Student Book:

- In Question 3 on Page 119 (snowy forest image), snow forms by crystallization when water changes from a liquid (or vapor) to a crystalline solid, releasing thermal energy.
- Correct option for Page 119 Question 3 is C: "When water changes state from a liquid to a solid, thermal energy is released."
- A crystalline solid has particles locked in a repeating, geometric 3D pattern (like six-sided snowflakes).

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Atmospheric Process	State Change	Thermal Energy Flow	Atmospheric Result
Evaporation / Transpiration	Liquid → Water Vapor (Gas)	Thermal energy is ABSORBED (gained)	Invisible water vapor rises into the atmosphere
Condensation	Water Vapor (Gas) → Liquid Droplets	Thermal energy is RELEASED (lost)	Clouds, fog, or dew droplets form
Crystallization	Liquid Water (or Vapor) → Solid Ice Crystals	Thermal energy is RELEASED (lost)	Snowflakes, frost, or ice crystals form at or below 0°C

Remember:

✓ Liquid → Solid (Crystallization / Freezing) = Thermal energy is RELEASED.

✓ Gas → Liquid (Condensation) = Thermal energy is RELEASED.

✓ Liquid → Gas (Evaporation) = Thermal energy is ABSORBED.

The Energy Exchange (Opposing Forces)

Evaporation (Liquid → Gas)	Condensation & Crystallization (Gas → Liquid/Solid)
Energy is ABSORBED (from the Sun)	Energy is RELEASED (to the colder atmosphere)
Occurs at warmer surface levels	Occurs as rising air cools at higher altitudes
Creates invisible water vapor	Creates visible clouds, fog, or ice



Reversing the Process: When you see dew on morning grass or spider webs, you are witnessing invisible atmospheric water vapor losing energy overnight and condensing back into a liquid right at the surface.

Questions :



Question 1: Examine the photo above. 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.

Question 2: What is the process called in which liquid water in clouds freezes into solid, six-sided ice crystals (snowflakes)?

(A) Evaporation	(B) Transpiration
(C) Condensation	(D) Crystallization

Question 3: During crystallization in the atmosphere, what happens to the thermal energy of the water particles?

(A) Thermal energy is absorbed from the clouds	(B) Thermal energy is released to the surrounding air
(C) Thermal energy doubles inside the crystal	(D) No thermal energy is transferred

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Question 4: During crystallization, what happens to the speed and kinetic energy of the water molecules?

(A) The molecules slow down, lose kinetic energy, and lock into fixed positions	(B) The molecules speed up and fly apart in straight lines
(C) The molecules gain kinetic energy and boil	(D) The molecules slide freely past one another

Question 5: How are the water molecules arranged inside an ice crystal (snowflake)?

(A) Randomly scattered far apart with no pattern	(B) Flowing freely in a disordered liquid layer
(C) In an orderly, repeating hexagonal (six-sided) pattern	(D) Compressed into a single point

Question 6: At what temperature does liquid water at standard pressure crystallize into ice?

(A) 0°C (or below)	(B) 32°C
(C) 50°C	(D) 100°C

Question 7: Which two processes in the water cycle RELEASE thermal energy into the atmosphere?

(A) Evaporation and melting	(B) Condensation and crystallization
(C) Evaporation and transpiration	(D) Melting and sublimation

Question 8: Which two processes in the water cycle ABSORB thermal energy from the environment?

(A) Condensation and freezing	(B) Crystallization and condensation
(C) Melting and evaporation	(D) Deposition and freezing

Question 9: In a water-cycle diagram, an arrow going from cloud droplets (liquid) to snowflakes (solid) represents:

(A) Evaporation	(B) Condensation
(C) Transpiration	(D) Crystallization

Question 10: In a water-cycle diagram, an arrow going from invisible water vapor (gas) to liquid cloud droplets represents:

(A) Evaporation	(B) Condensation
(C) Crystallization	(D) Melting

Question 11: In a water-cycle diagram, an arrow going from ocean water (liquid) to water vapor (gas) in the air represents:

(A) Evaporation	(B) Condensation
(C) Crystallization	(D) Infiltration

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Question 12: When the Sun shines on the snowy forest in spring and the snow turns back into liquid water, what happens to thermal energy?

(A) The snow releases thermal energy and freezes harder	(B) The snow condenses from a gas to a liquid
(C) The snow absorbs thermal energy and melts	(D) Thermal energy flows from the 0°C snow into the warm Sun

Question 13: What must be present in the atmosphere for water vapor to condense upon and form cloud droplets or ice crystals?

(A) Pure vacuum with no particles	(B) Tiny solid particles such as dust, salt, or pollen (condensation nuclei)
(C) Boiling water at 100°C	(D) Large blocks of granite

Question 14: Why is solid ice LESS dense than liquid water (allowing ice to float on water)?

(A) During crystallization, water molecules form an open six-sided crystal structure that takes up slightly more space	(B) Ice molecules lose half of their mass when they freeze
(C) Liquid water has no molecules in it	(D) Ice is hotter than liquid water

Question 15: Which sequence correctly traces a water molecule from the ocean to a snowflake falling on a mountain?

(A) Crystallization → Evaporation → Runoff → Condensation	(B) Condensation → Infiltration → Evaporation → Boiling
(C) Evaporation → Condensation → Crystallization → Precipitation	(D) Melting → Freezing → Evaporation → Transpiration

Q18 : Module 3: Weather and Climate

Lesson 2: Atmospheric and Oceanic Circulation

Interpret maps/models of winds & currents.

(Page 186)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Three-Dimensional Thinking · Page 186)

Global winds blowing across the ocean push surface water to create horizontal surface currents. On Page 186, the Upwelling model shows what happens when strong winds blow parallel to a coastline (or push surface water away from the coast): the warm surface water is pushed offshore, and deep, cold, nutrient-rich water rises up from the ocean floor to replace it. This vertical upward movement of cold water is called upwelling, and the nutrients it brings to the sunlit surface support large populations of microscopic algae (phytoplankton) and fish. On global ocean maps (Page 189), surface currents are deflected by the Coriolis effect and continental landmasses to form five huge circular systems called ocean gyres, which rotate clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. Deep density currents and surface currents connect in the Great Ocean Conveyor Belt (Page 190) to transport thermal energy around the globe.

Key Ideas from the Student Book:

- In Three-Dimensional Thinking on Page 186, wind pushes warm surface water away from the shore, causing cold, nutrient-rich deep water to rise (upwelling).
- Upwelling zones are among the richest fishing grounds on Earth because rising nutrients feed plankton, which feed fish.
- In Ocean Gyres maps ,warm currents (red arrows) carry warm water from the equator toward the poles, while cold currents (blue arrows) carry cold water from high latitudes back toward the equator.

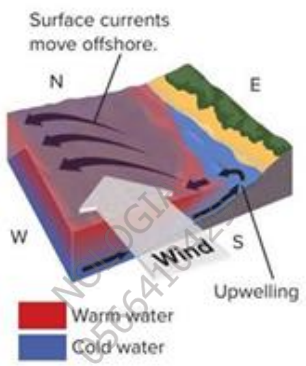
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Ocean Circulation Feature	Cause / Mechanism	Effect on Ocean & Climate
Surface Currents	Driven mainly by global winds pushing the top ~100-400 m of ocean water	Warm currents from the equator warm coastal climates; cold currents from the poles cool coastal climates
Upwelling	Wind blows warm surface water away from the coast; deep, cold water rises to replace it	Brings rich nutrients from the ocean floor to the surface, supporting thriving fish and marine life
Ocean Gyres	Global winds + Coriolis effect + continent shapes create 5 large circular loops	Rotate clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere
Great Ocean Conveyor Belt	Driven by temperature and salinity (density) differences + winds	Slowly circulates water and thermal energy through all of Earth's oceans

Remember:

✓ Upwelling = Surface wind pushes warm surface water away → Cold, nutrient-rich deep water rises to replace it.

✓ Ocean Gyres = Clockwise in Northern Hemisphere; Counterclockwise in Southern Hemisphere.



The Three Pillars of Oceanic Movement

Column 1: Surface Currents	Column 2: Density Currents	Column 3: Upwelling
Driver: Wind friction **Direction:** Horizontal (Top layer) **Key Feature:** Forms large circular Gyres due to landmass deflection.	**Driver:** Temperature & Salinity variations **Direction:** Vertical (Sinking to seafloor) **Key Feature:** Originates at the poles where freezing water leaves salt behind.	**Driver:** Wind displacement **Direction:** Vertical (Rising to surface) **Key Feature:** Brings cold, nutrient-rich water to support marine ecosystems.

Questions :

Question 1: Using what you have learned about Earth's major wind systems, model the directions of the wind system and the ocean waters during upwelling. How does the wind influence the movement of water?

(A) Winds blowing along a coast push warm surface water away from the shore, allowing deeper, colder, nutrient-rich water to rise to the surface (upwelling), while global winds also drive circular surface currents (gyres).	(B) Winds heat the bottom of the ocean so boiling water rises to the shore.
(C) Winds blow straight downward into the ocean trench, stopping all currents.	(D) Warm surface water sinks because it is denser than cold deep water.

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Question 2: What is "upwelling"?

(A) The evaporation of warm water into thunderclouds	(B) The vertical movement of cold, nutrient-rich water from deep in the ocean up to the surface
(C) The sinking of warm water at the equator	(D) The freezing of rivers in winter

Question 3: Why are areas of ocean upwelling so important for marine organisms like fish and seabirds?

(A) Upwelling makes the surface water boiling hot	(B) Upwelling removes all salt from the ocean
(C) Rising deep water brings abundant nutrients to the sunlit surface, supporting plankton and large fish populations	(D) Upwelling stops all wind from blowing

Question 4: What is the main force that drives horizontal SURFACE currents in the top layer of the ocean?

(A) Global winds blowing across the ocean surface	(B) Earthquakes on the sea floor
(C) Swimming fish and whales	(D) Groundwater flowing uphill

Question 5: What are the five large, circular systems of ocean surface currents called?

(A) Jet streams	(B) Aquifers
(C) Water tables	(D) Ocean gyres

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Question 6: In which direction do ocean gyres circulate in the NORTHERN Hemisphere (such as the North Atlantic and North Pacific gyres)?

(A) Clockwise	(B) Counterclockwise
(C) Straight north to south with no curve	(D) Straight up and down

Question 7: In which direction do ocean gyres circulate in the SOUTHERN Hemisphere (such as the South Atlantic, South Pacific, and Indian Ocean gyres)?

(A) Clockwise	(B) Counterclockwise
(C) Straight east to west around the North Pole	(D) They do not move at all

Question 8: Which two factors cause surface ocean currents to form large circular gyres instead of moving in straight lines around the globe?

(A) Clouds and rainstorms only	(B) Sunlight and snow
(C) The Coriolis effect (Earth's rotation) and continental landmasses blocking and deflecting the water	(D) Tides and sea breezes only

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Question 9: On a map of ocean currents, a red arrow pointing from the equator toward higher latitudes (like the Gulf Stream) represents:

(A) A warm surface current carrying thermal energy toward the poles	(B) A cold deep current flowing from the North Pole
(C) A frozen glacier moving across land	(D) A cold current cooling the equator

Question 10: On a map of ocean currents, a blue arrow pointing from high latitudes toward the equator (like the California Current) represents:

(A) A boiling hot current from the equator	(B) A cold surface current carrying cool water toward the equator
(C) A desert wind belt	(D) Evaporation of groundwater

Question 11: How does a warm ocean current (such as the Gulf Stream / North Atlantic Drift) affect the climate of nearby coastal land (such as Western Europe)?

(A) It causes the coast to freeze into a permanent ice cap	(B) It makes the climate much colder and drier
(C) It has no effect on coastal air temperatures	(D) It transfers thermal energy to the air, making the coastal climate warmer and more humid than expected for its latitude

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Question 12: How does a cold ocean current (such as the California Current) affect the climate of the nearby coast?

(A) It makes summer temperatures boiling hot	(B) It causes tropical rainforests to grow in the desert
(C) It cools the air above it, giving the coast cooler summer temperatures	(D) It stops all ocean waves

Question 13: What drives DEEP ocean currents (the Great Ocean Conveyor Belt) beneath the surface layer?

(A) Local sea breezes only	(B) Differences in water density caused by temperature and salinity (saltiness)
(C) Sunlight reaching the deepest ocean trenches	(D) Wind vanes on ships

Question 14: Which sample of seawater has the HIGHEST density and will sink to the bottom of the ocean?

(A) Cold seawater with high salinity (very salty)	(B) Warm seawater with low salinity
(C) Warm freshwater from a river	(D) Hot surface water at the equator

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Question 15: Near the poles, when sea ice freezes at the ocean surface, what happens to the salt in the unfrozen water just below the ice?

(A) The salt evaporates into the clouds	(B) The water becomes pure freshwater and floats higher
(C) The water warms up to 50°C	(D) The salt is left behind, making the cold unfrozen water saltier, denser, and causing it to sink

Question 16: What is the main global role of both atmospheric winds and the Great Ocean Conveyor Belt?

(A) They move thermal energy from the cold poles to the hot equator	(B) They prevent water from evaporating anywhere on Earth
(C) They redistribute thermal energy from the warm tropics toward the colder poles	(D) They keep the equator frozen all year

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Q19 : Module 3: Weather and Climate

Lesson 3: Weather Patterns

Use temperature, air-pressure, and particle-model evidence to explain differences between warm and cool air masses.

(Page 208)

Multiple Choice Questions - MCQ

Structured Concept Explanation (How do differences in pressure affect weather? - Investigation · Page 208)

Air pressure is the force exerted by the weight of a column of air above a given area. In the Investigation "Pressure Changes" (Page 208), particle models compare a column of cool air to a column of warm air: (1) In a cool air mass, air molecules move slower and are packed closer together, making cool air MORE dense. Because more molecules fit in the column, it weighs more and exerts HIGH air pressure (H) at the surface. High-pressure air sinks toward the ground and warms up, preventing clouds from forming and bringing clear skies and fair, dry weather. (2) In a warm air mass, air molecules have more kinetic energy, move faster, and spread farther apart, making warm air LESS dense. Because fewer molecules are in the column, it weighs less and exerts LOW air pressure (L). Low-pressure warm air rises into the atmosphere, where it cools and condenses into clouds, bringing cloudy skies and precipitation.

Key Ideas from the Student Book:

- In the particle-column diagram on Page 208, the left column (Cool air molecules) has tightly packed particles = higher density = heavier weight = High Pressure (H).
- The right column (Warm air molecules) has widely spaced particles = lower density = lighter weight = Low Pressure (L).
- Rising air in a Low-Pressure system (L) cools and condenses to form clouds and precipitation; sinking air in a High-Pressure system (H) warms and inhibits cloud formation.

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Feature	Cool Air Mass / High Pressure (H)	Warm Air Mass / Low Pressure (L)
Particle Motion & Spacing	Molecules move slower and are packed CLOSER together	Molecules move faster and are spread FARTHER apart
Density & Column Weight	MORE dense → heavier column of air	LESS dense → lighter column of air
Air Pressure Symbol	High Pressure (blue H on weather maps)	Low Pressure (red L on weather maps)
Vertical Air Movement	Air SINKS toward Earth's surface and spreads outward	Air converges and RISES into the troposphere
Resulting Weather	Clear skies, sunny, calm, fair/dry weather	Cloudy skies, condensation, rain/snow (stormy weather)

Remember:

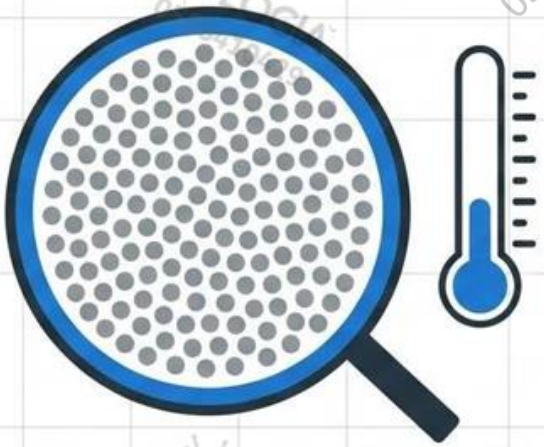
✓ Cool Air = Molecules close together → More dense → Sinks → High Pressure (H) → Clear, fair weather.

✓ Warm Air = Molecules far apart → Less dense → Rises → Low Pressure (L) → Clouds and precipitation.

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The Physics of Air Pressure



High Density = High Pressure

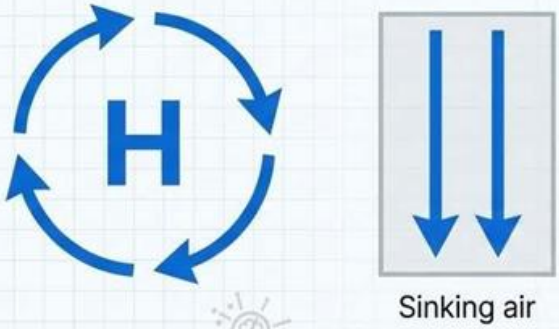
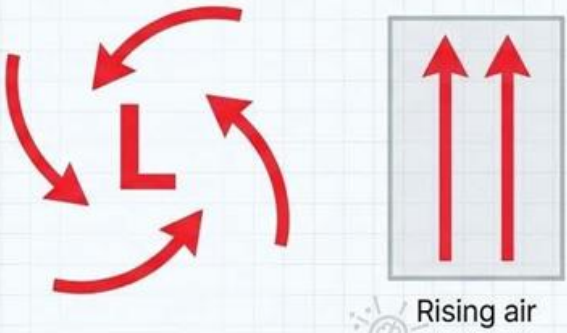
- Cool air molecules are packed closer together, creating more weight and downward pressure.



Low Density = Low Pressure

- Warm air molecules spread apart, reducing weight and pressure, allowing the air to rise.

Diagnosing Pressure Systems: Highs vs. Lows

High-Pressure System (H)	Low-Pressure System (L)
	
• **Mechanism:** Dense, cool air sinks. • **Resulting Weather:** Clouds cannot form. Brings clear skies and fair weather.	• **Mechanism:** Less dense, warm air rises and cools. • **Resulting Weather:** Water vapor condenses. Associated with cloudy weather and precipitation.

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Questions :



Question 1: 1. In each circle, model the distribution of air molecules based on the location's temperature and pressure.

2. Describe whether air in a high-pressure system rises or sinks.

3. Explain why the temperature on land is higher than over water."

(A) Left circle (Low Temp, High Pressure over water): molecules packed closely together (denser), causing high-pressure air to sink. Right circle (High Temp, Low Pressure over land): molecules spread farther apart (less dense, rises) because land has a lower specific heat than water and heats up faster.	(B) Left circle: molecules spread far apart and rising. Right circle: molecules packed tightly together and sinking.
(C) Air in a high-pressure system rises rapidly to form thunderstorms, while air in a low-pressure system sinks.	(D) Temperature on land is higher because land has a specific heat 6 times higher than water.

Question 2: How are the air molecules arranged in a WARM air mass compared to a cool air mass?

(A) They move slower and are packed closer together	(B) They move faster and are spread farther apart (less dense)
(C) They are locked in a solid crystal pattern	(D) They do not move at all

Question 3: How does the density of a cool air mass compare to the density of a warm air mass?

(A) Cool air is more dense than warm air	(B) Warm air is more dense than cool air
(C) Both have the exact same density	(D) Neither air mass has density

Question 4: What type of air pressure system is created when a warm, less dense column of air rises?

(A) A high-pressure system (H)	(B) A stationary glacier
(C) A low-pressure system (L)	(D) An ocean gyre

Question 5: What type of air pressure system is created when a cool, dense column of air sinks toward Earth's surface?

(A) A high-pressure system (H)	(B) A low-pressure system (L)
(C) A hurricane eye	(D) An upwelling zone

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Question 6: What kind of weather is typically associated with a HIGH-pressure system (H)?

(A) Heavy thunderstorms and tornadoes	(B) Thick clouds and continuous rain
(C) Blizzards and hail	(D) Clear skies, sunshine, and fair, dry weather

Question 7: What kind of weather is typically associated with a LOW-pressure system (L)?

(A) Clear, sunny, and completely dry skies	(B) Cloudy skies and precipitation (rain or snow)
(C) Sinking dry air with zero clouds	(D) Drought and desert heat

Question 8: Why do clouds and rain form in a low-pressure system (L)?

(A) Cold dry air sinks to the ground and evaporates all clouds	(B) Sunlight boils the clouds away
(C) Warm, moist air rises, cools at higher altitudes, and its water vapor condenses into clouds	(D) Gravity pushes water vapor into the soil

Question 9: Why do clouds NOT easily form in the center of a high-pressure system (H)?

(A) Air sinks toward the surface and warms up as it descends, preventing water vapor from condensing	(B) Air rises rapidly and freezes into hail
(C) High pressure pulls ocean water directly into the sky	(D) There is no nitrogen or oxygen in high-pressure air

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Question 10: What is an "air mass"?

(A) A single cloud droplet in the sky	(B) A large body of air that has similar temperature, humidity, and pressure throughout
(C) A deep ocean current near Antarctica	(D) A thermometer used at weather stations

Question 11: How does an air mass get its temperature and moisture characteristics?

(A) From the Moon's phases	(B) From airplanes flying through it
(C) From deep underground aquifers	(D) From the source region (land or ocean, polar or tropical) over which it forms and lingers

Question 12: An air mass that forms over a warm tropical ocean (Maritime Tropical) will be:

(A) Cold and dry	(B) Cold and humid
(C) Warm and humid (moist)	(D) Frozen and dry

Question 13: An air mass that forms over cold northern land in winter (Continental Polar) will be:

(A) Cold and dry	(B) Hot and humid
(C) Warm and rainy	(D) Tropical and moist

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Question 14: Which weather instrument is used to measure air (barometric) pressure?

(A) An anemometer	(B) A barometer
(C) A rain gauge	(D) A wind vane

Question 15: If a weather station barometer shows that air pressure is falling rapidly, what weather change is most likely approaching?

(A) A high-pressure system bringing sunny, dry skies	(B) Calm, cloudless weather for a week
(C) Freezing of the barometer mercury at 50°C	(D) A low-pressure system bringing clouds and precipitation

Question 16: comparing the Cool Air column to the Warm Air column: Cool air has _____ density, _____ weight, and _____ air pressure.

(A) greater; more; higher	(B) lower; less; lower
(C) greater; less; lower	(D) zero; zero; zero

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Q20 : Module 2: The Water Cycle

Lesson 1: Water in the Atmosphere

Identify and classify the four Earth subsystems (atmosphere, hydrosphere, geosphere, biosphere) and explain how they interact.

(Page 108)

Multiple Choice Questions - MCQ

Structured Concept Explanation (Three-Dimensional Thinking · Page 108):

Earth consists of four major interacting subsystems (spheres): (1) The Atmosphere is the layer of gases (air, water vapor, oxygen, nitrogen, carbon dioxide) surrounding Earth; (2) The Hydrosphere includes all water on, under, and above Earth's surface (oceans, lakes, rivers, groundwater, glaciers, rain, and cloud droplets); (3) The Geosphere is the solid body of Earth, including rocks, cliffs, mountains, soil, sand, and the seafloor; and (4) The Biosphere includes all living organisms on Earth (plants, trees, animals, birds, bacteria, and humans). These four subsystems constantly interact through the water cycle: for example, ocean water (hydrosphere) evaporates into the air (atmosphere), falls as rain to weather and erode rocky cliffs and water soil (geosphere), and is absorbed by trees and drunk by animals (biosphere), while plants release water vapor back into the atmosphere via transpiration.

Key Ideas from the Student Book:

- In the coastal cave photo on Page 108: Top-left box (sky/air) = Atmosphere; Top-right box (green shrubs on cliff) = Biosphere; Bottom-left box (rocky cave cliff) = Geosphere; Bottom-right box (ocean water) = Hydrosphere.
- In the photo, ocean waves (hydrosphere) crash against and carve the rocky cliff into a sea cave (geosphere), while plants (biosphere) grow in the soil (geosphere) and exchange gases/water vapor with the air (atmosphere).
- A change in one sphere always affects the other spheres.

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Earth Subsystem	Prefix Meaning	What It Includes (Examples in Page 108 Photo)	How It Interacts in the Water Cycle
Atmosphere	Atmo = Air / Vapor	Air, sky, wind, invisible water vapor, gases	Holds water vapor and transports clouds via winds
Hydrosphere	Hydro = Water	Ocean waves, sea water in the cave, rivers, glaciers, groundwater, rain	Provides liquid water for evaporation; erodes coastal rocks
Geosphere	Geo = Earth / Rock	Rocky cave walls, cliffs, sea stacks, sand, soil, pebbles	Shaped/carved by crashing ocean waves and rainfall runoff; stores groundwater
Biosphere	Bio = Life	Green plants/shrubs growing on top of the cliff, seabirds, marine life, humans	Plants absorb water from soil and release water vapor (transpiration)

Remember:

✓ Atmosphere = Air & gases.

✓ Hydrosphere = All water (oceans, rivers, ice, groundwater).

✓ Geosphere = Solid Earth (rocks, cliffs, soil, sand).

✓ Biosphere = All living things (plants, animals, humans).

Where is water on Earth?

Earth is often referred to as the blue planet because so much of its surface is covered with water. If you study a photograph of Earth taken from space, you can see that water covers much more of Earth than landmasses do. Water is also in the clouds in the atmosphere, the air around you, beneath your feet, and in you and other organisms.

The distribution of water on Earth depends on the interactions among the four subsystems of the larger Earth system. Four of these smaller subsystems are the atmosphere, the biosphere, the geosphere, and the hydrosphere.

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Earth's Interconnected Subsystems

Atmosphere

The layers of gases (air) surrounding the planet, holding invisible water vapor and visible clouds.

Biosphere

All living organisms (plants, animals) that rely on and cycle water.



Hydrosphere

All liquid and solid water on Earth (oceans, rivers, lakes, glaciers).

Geosphere

The solid Earth (landmasses, mountains, soil).

Key Insight: Water distribution depends on c[illegible] interaction between these four subsystems.

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Questions :



Question 1: With a partner, label the subsystems of the larger Earth system in the photo

. How do you think water moves between the subsystems?

(A) Top-left (rocky cave) = Geosphere; Top-right (sky/air) = Atmosphere; Middle-right (trees) = Biosphere; Bottom (ocean) = Hydrosphere. Water evaporates from the hydrosphere to the atmosphere, falls as rain onto the geosphere, and is used by the biosphere.	(B) Top-left = Biosphere; Top-right = Hydrosphere; Middle-right = Atmosphere; Bottom = Geosphere.
(C) Top-left = Hydrosphere; Top-right = Geosphere; Middle-right = Biosphere; Bottom = Atmosphere.	(D) Water stays permanently in the ocean and never enters the atmosphere, geosphere, or biosphere.

Question 2: Which Earth subsystem includes all living organisms, such as trees, birds, fish, and humans?

(A) Atmosphere	(B) Hydrosphere
(C) Geosphere	(D) Biosphere

Question 3: Which Earth subsystem includes all oceans, rivers, lakes, glaciers, and underground aquifers?

(A) Atmosphere	(B) Hydrosphere
(C) Geosphere	(D) Biosphere

Question 4: Which Earth subsystem includes solid rocks, mountains, cliffs, sand dunes, and the ocean floor?

(A) Atmosphere	(B) Hydrosphere
(C) Geosphere	(D) Biosphere

Question 5: Which Earth subsystem is the envelope of gases surrounding Earth?

(A) Atmosphere	(B) Hydrosphere
(C) Geosphere	(D) Biosphere

Question 6: When ocean waves carve out a rocky sea cave along a coast which two Earth subsystems are directly interacting?

(A) Biosphere and atmosphere only	(B) Hydrosphere and geosphere
(C) Atmosphere and outer space	(D) Biosphere and biosphere

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Question 7: When a tree's roots absorb groundwater from the soil and its leaves release water vapor into the air by transpiration, which subsystems are interacting?

(A) Geosphere only	(B) Atmosphere and hydrosphere only
(C) Biosphere only	(D) Hydrosphere, geosphere, biosphere, and atmosphere

Question 8: When liquid water evaporates from the surface of a lake into the warm air above it, which two subsystems are interacting?

(A) Hydrosphere and atmosphere	(B) Geosphere and biosphere
(C) Biosphere and geosphere	(D) Geosphere and core

Question 9: When a desert fox digs a burrow into sandy soil to escape the midday heat, which two subsystems are directly interacting?

(A) Hydrosphere and atmosphere	(B) Hydrosphere and geosphere
(C) Biosphere and geosphere	(D) Atmosphere and hydrosphere

Question 10: To which Earth subsystem do frozen glaciers and polar ice caps belong?

(A) Biosphere	(B) Hydrosphere
(C) Atmosphere	(D) Geosphere

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Question 11: When humans breathe in oxygen from the air and breathe out carbon dioxide, which two subsystems are interacting?

(A) Biosphere and atmosphere	(B) Geosphere and hydrosphere
(C) Hydrosphere and geosphere	(D) Geosphere and atmosphere

Question 12: When heavy rain washes soil down a hillside into a muddy river, which two subsystems are primarily interacting?

(A) Biosphere and atmosphere	(B) Atmosphere and biosphere
(C) Hydrosphere and geosphere	(D) Biosphere only

Question 13: When strong desert winds blow sand grains to form giant sand dunes, which two subsystems are interacting?

(A) Biosphere and hydrosphere	(B) Hydrosphere and biosphere
(C) Biosphere only	(D) Atmosphere and geosphere

Question 14: Fish swimming in a coral reef and absorbing dissolved oxygen from the seawater is an interaction between the:

(A) Atmosphere and geosphere	(B) Biosphere and hydrosphere
(C) Geosphere and atmosphere	(D) Atmosphere only

Question 15: In which layer of the atmosphere does almost all weather and cloud formation in the water cycle occur?

(A) The troposphere	(B) The exosphere
(C) The inner core of the geosphere	(D) The thermosphere

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Q21 : Module 1: Energy and Matter

Lessons 1, 3 & 4: Particles in Motion · Thermal Energy Transfers · Conductivity

1) Describe how heating and cooling change particle motion.

2) Describe how mass affects heating and cooling rate.

3) Interpret investigation data or models of energy transfer

(Pages 5 , 59 , 78)

Free Response Questions - FRQ

Structured Concept Explanation (Lesson Launch 1: Fruit Pops (Page 5) · Data and Observations (Page 59) · Collect Evidence (Page 78) · Page 5, Page 59, Page 78):

This Free Response item integrates three core concepts from Module 1: (1) Heating and Cooling Particle Motion (Page 5, Fruit Pops): When liquid fruit juice is placed in a cold freezer, thermal energy flows out of the juice into the colder freezer air. Cooling causes the juice particles to lose kinetic energy, move slower, move closer together, and lock into fixed vibrating positions as a solid fruit pop. Conversely, heating adds thermal energy, causing particles to gain kinetic energy, move faster, and spread slightly farther apart (melting the pop on a warm day). (2) Effect of Mass on Heating and Cooling Rate (Page 78): For the same thermal energy input, temperature change is inversely proportional to mass. A smaller mass (fewer particles) heats up and cools down much faster than a larger mass (more particles), while a larger mass requires more thermal energy to achieve the same temperature change. (3) Interpreting Energy Transfer Data (Page 59): In the two-beaker investigation, data tables show that the temperature of the hot water (source) decreases over time while the temperature of the cold water (receiver) increases until both approach the same temperature (thermal equilibrium).

Key Ideas from the Student Book:

• Lesson Launch: Fruit Pops (Page 5): Freezing juice into a solid pop requires removing thermal energy so particles slow down and lock in place.

• Data and Observations (Page 59): In any heat-transfer table, the warmer sample's temperature decreases and the cooler sample's temperature increases until thermal equilibrium.

• Collect Evidence (Page 78): Greater mass means more particles to heat up, resulting in a slower rate of temperature change.

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Sub-Topic & Page	Scientific Principle	Model Answer Summary for Exam
1. Heating & Cooling Particle Motion	Heating adds thermal energy → kinetic energy & particle speed increase. Cooling removes thermal energy → kinetic energy & particle speed decrease.	Cooling fruit juice removes heat, slowing particles until they vibrate in fixed solid positions; heating speeds particles up so the pop melts.
2. Mass & Heating/Cooling Rate	Inversely proportional (same heat): Larger mass = slower heating/cooling rate (smaller ΔT). Directly proportional: Larger mass = more heat needed for same ΔT.	A small pot of water has fewer particles so its temperature rises and falls much faster than a large pot.
3. Energy Transfer Data	Heat flows from hot inner beaker (source) to cold outer beaker (receiver) until thermal equilibrium is reached.	Hot water temperature drops (e.g., 70°C → 34°C) while cold water temperature rises (e.g., 15°C → 34°C) until both are equal.

Remember:

✓ Heating = Particles gain kinetic energy, move faster, spread apart.

✓ Cooling = Particles lose kinetic energy, move slower, move closer together.

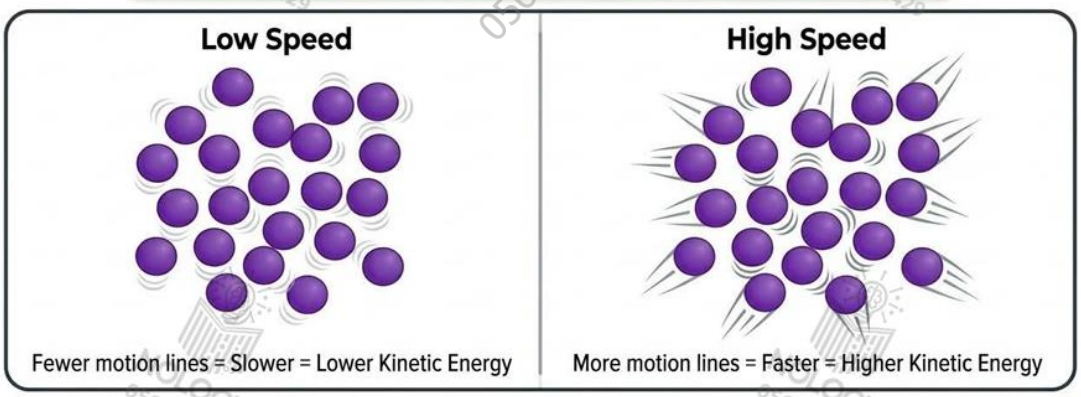
✓ More Mass = Slower heating and cooling rate (smaller ΔT for the same heat).

✓ Data Table Rule = Hot object cools down + Cold object warms up → Thermal Equilibrium.

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Kinetic Energy & Modeling Speed

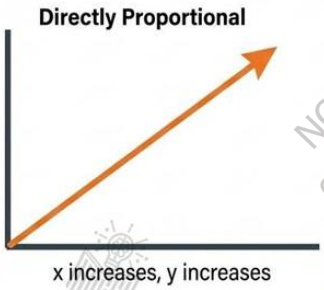
Kinetic Energy: The energy an object has because of its motion. The faster particles move, the more kinetic energy they have.

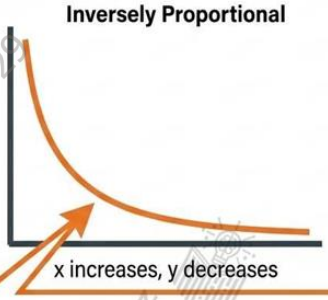


How Scientists Draw It: We use motion lines in diagrams to represent speed. This allows us to see the invisible energy in a still image.

Variable 1: The Impact of Mass on Temperature Change

Mass determines the amount of thermal energy in a substance. More particles = more energy required from the surroundings to increase kinetic energy.

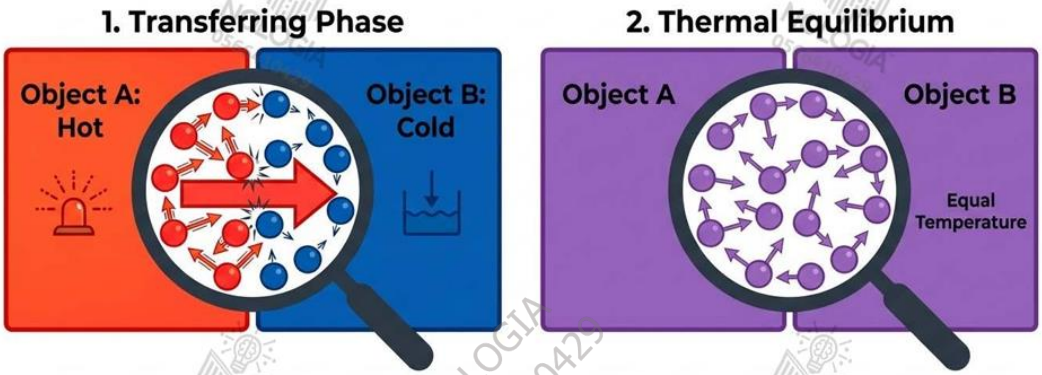




For a constant energy input, the change in temperature vs. mass is an inversely proportional relationship. (e.g., A small pot of water heats up much faster than a large pot of water).

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Thermal Equilibrium



- **Thermal Equilibrium:** Temperatures are perfectly equal.
- **The Particle Reality:** Particles continue to collide and transfer kinetic energy back and forth, but the average kinetic energy of both materials remains exactly the same.

Questions :

Fruit Pops



Question 1: To make a fruit pop, you put liquid juice inside a freezer. The cold air inside the freezer lowers the temperature of the juice, and its state of matter changes. Which statement do you think is correct?

(A) Increased temperature means particles have less motion.

(B) Decreased temperature means particles have greater motion.

(C) Increased temperature means particles have greater motion.

(D) Particle motion is unaffected by temperature. Explain your reasoning.

Question 2: Sketch a particle model to explain the relationship between change in temperature and mass. How does the mass of a material in the kitchenware affect how it transfers thermal energy?

Question 3: 1. Identify any patterns in the data.

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

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

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Question 4: How does adding thermal energy (heating) affect the speed and kinetic energy of particles in a sample of matter?

Question 5: How does removing thermal energy (cooling) affect the speed and kinetic energy of particles in a sample of matter?

Question 6: which direction does thermal energy flow when liquid juice at 20°C is placed in a freezer at –10°C?

Question 7: Compare the particle motion of fruit juice before freezing (liquid) and after freezing (solid).

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Question 8: Two beakers contain water at 20°C: Beaker A has 100 g of water and Beaker B has 400 g of water. If both are heated on identical hot plates for 3 minutes, which beaker will have a higher temperature, and why?

Question 9: Using the same two beakers (100 g vs. 400 g), if both are heated until they reach 80°C and then removed from the hot plate, which beaker will cool down faster?

Question 10: State whether the relationship between mass and temperature change (for a fixed amount of thermal energy) is directly proportional or inversely proportional.

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Q22 : Module 2: The Water Cycle (and Module 3)

Lesson 2: Water on Earth's Surface

1) Identify precipitation, runoff and reservoirs.

2) Identify water reservoirs and water-cycle processes shown in a model.

3) Use a water-cycle model to explain water movement and storage.

(Pages 126-127, 131-133, 216)

Free Response Questions - FRQ

Structured Concept Explanation (Why do some clouds rain? (Pages 126-127; 216) · Where is Water Stored? (Pages 131-133) · Pages 126-127, 131-133, 216):

This Free Response item covers how water falls from clouds, flows across land, and is stored in Earth's reservoirs: (1) Why Some Clouds Rain & Precipitation (Pages 126-127, 216): Cloud droplets are extremely tiny and kept aloft by rising air currents (updrafts). Inside thick clouds (often formed along weather fronts where warm air rises over cold air, p. 216), millions of microscopic droplets collide and combine (coalesce) into larger, heavier drops— or freeze into ice crystals. Once the drops or ice crystals become too heavy for updrafts to support, gravity pulls them down to Earth's surface as precipitation (rain, snow, sleet, or hail). (2) Runoff, Infiltration, and Reservoirs in a Water-Cycle Model (Pages 131-133): When precipitation reaches land, gravity pulls it downhill over the surface as runoff into streams, rivers, and lakes, or pulls it downward through pores in permeable soil and rock (infiltration) to be stored as groundwater in aquifers. Water is stored in five main reservoirs shown in the model on Page 131: Oceans (~97% saltwater), Glaciers & Ice Caps (largest freshwater reservoir), Groundwater (second largest freshwater reservoir), Surface Water (lakes, rivers, streams), and the Atmosphere.

Key Ideas from the Student Book:

• Why do some clouds rain? (pp. 126-127): Not all clouds produce rain; droplets must collide and grow heavy enough for gravity to overcome air updrafts.

• Forms of precipitation depend on air temperature: Rain (liquid drops > 0°C), Snow (ice crystals formed by crystallization ≤ 0°C), Sleet (raindrops that freeze while falling through a cold layer of air), and Hail (layered ice balls formed by strong updrafts in cumulonimbus thunderclouds).

• In the Water-Cycle Model (p. 131), solar energy drives evaporation/transpiration upward, while gravity drives precipitation, runoff, glacier flow, and groundwater downward back to the ocean.

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Model Label / Component	Category (Process vs. Reservoir)	Scientific Explanation of Movement / Storage
Why Clouds Rain (Precipitation)	Process (Atmosphere → Surface)	Tiny cloud droplets collide and combine until they are too heavy; gravity pulls them down as rain, snow, sleet, or hail
Surface Runoff	Process (Land → Rivers/Oceans)	Gravity pulls excess rain/melted snow downhill over land into streams, rivers, lakes, and oceans
Infiltration & Groundwater Flow	Process (Surface → Underground)	Water soaks into permeable soil/rock and flows slowly underground toward the ocean
Oceans, Glaciers, Groundwater, Lakes/Rivers	Reservoirs (Storage Areas)	Oceans store 97% (saltwater); Glaciers store most freshwater as ice; Groundwater stores liquid freshwater in aquifers

Remember:

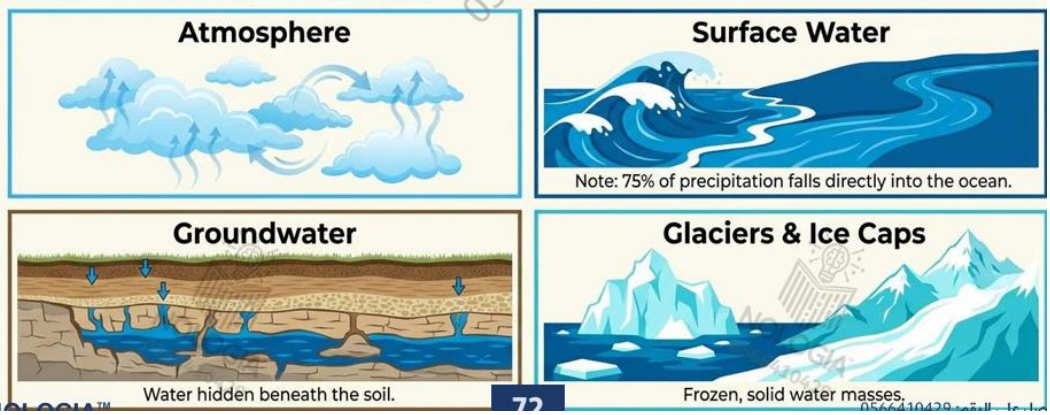
✓ Precipitation = Cloud droplets combine & grow heavy → Gravity pulls them down (rain, snow, sleet, hail).

✓ Runoff = Gravity moves surface water downhill into rivers, lakes, and oceans.

✓ Reservoirs in Model = Oceans (largest total), Glaciers (largest freshwater), Groundwater (aquifers), Lakes/Rivers, Atmosphere.

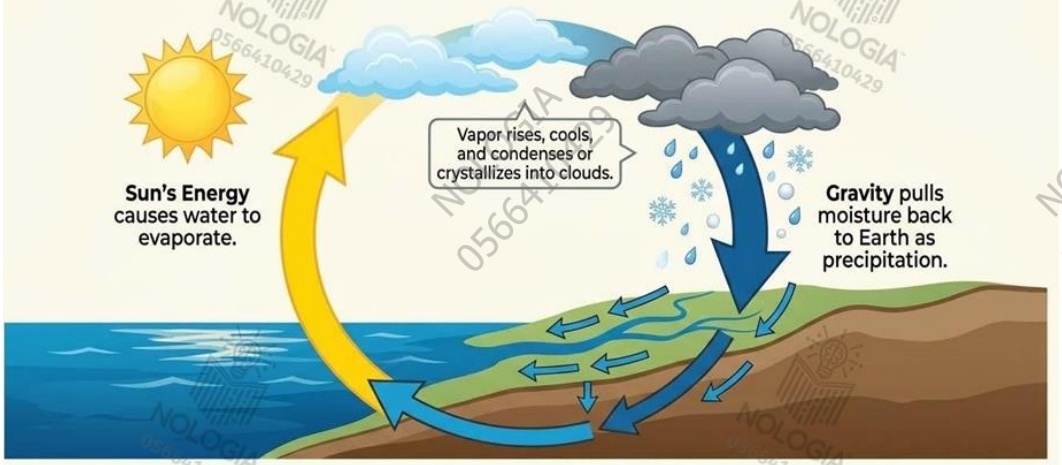
The Golden Rule of Earth's Water

The total amount of water on Earth does not change.
It simply moves between different reservoirs.



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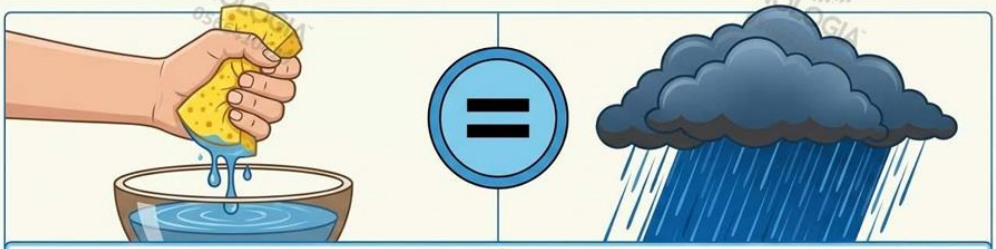
The Engine of the Water Cycle



The cycle is infinite. Water evaporates, precip nd flows, but the total volume remains stable.

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Atmospheric Water: Why Do Clouds Rain?



Just like a sponge lifted from a bowl of water, a cloud can only hold so much moisture.

Precipitation: Moisture that falls from clouds to Earth's surface.



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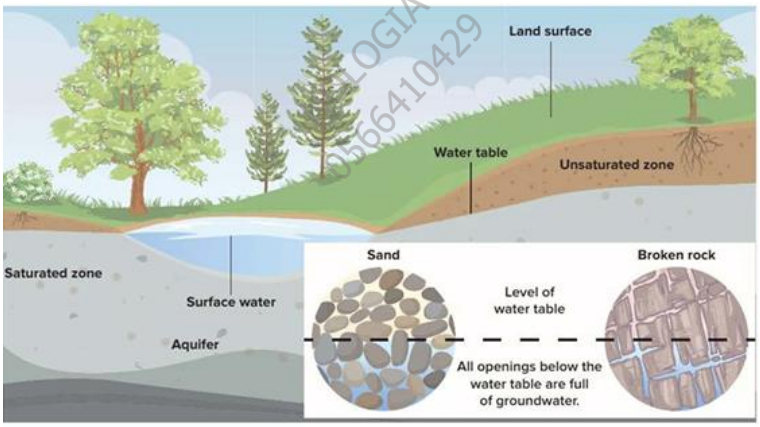
Questions :



Question 1: 1. What caused the food coloring to fall through the shaving cream?

2. How does your model represent how clouds produce rain? Collect Evidence: Why do some clouds rain?"

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Question 2: 1. Draw arrows on the figure to model how you think groundwater might flow.

2. How did you decide to draw the arrows?

3. What force causes groundwater to flow?

4 .How does water become groundwater and where else is water stored?

Water Reservoirs in the Model	Processes Moving Water into the Air	Processes Returning Water to Oceans

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Question 3: Why don't all clouds drop rain immediately as soon as they form?

Question 4: Name the four main types of precipitation.

Question 5: What is the difference between surface runoff and infiltration?

Question 6: List the five water reservoirs shown in the diagram.

Question 7: How does water stored in a mountain glacier eventually return to the ocean?

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Question 8: How do weather fronts help cause cloud formation and precipitation?

Question 9: Complete the table identifying the four types of precipitation and how each forms:

Precipitation Type	State of Matter	How It Forms in the Atmosphere
Rain		
Snow		
Sleet		
Hail		

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Q23 : Module 2: The Water Cycle

Lessons 1 & 2: Water in the Atmosphere · Water on Earth's Surface

1) Describe how energy changes cause melting, freezing and evaporation.

2) Describe how heating and cooling cause evaporation, condensation and crystallization.

3) Explain examples of state changes in daily life and connect them to the water cycle.

(Pages 103 , 111 , 135)

Free Response Questions - FRQ

Structured Concept Explanation (Three-Dimensional Thinking (Page 111) · Three-Dimensional Thinking (Page 135 Q3 · Lesson Launch 1: What happened to the puddle? (Page 103) · Page 103, Page 111, Page 135):

This Free Response item connects thermal energy transfers (heating and cooling) to state changes in daily life and the water cycle: (1) Energy Changes in Melting, Freezing, and Evaporation (Page 111 & Module 1 Lesson 2): Adding thermal energy (heating) increases particle kinetic energy so particles overcome attractions—causing melting (solid ice → liquid water, such as snow melting in spring) and evaporation (liquid water → water vapor gas at the surface). Removing thermal energy (cooling) decreases particle kinetic energy so attractions pull particles together—causing freezing (liquid → solid). (2) Heating and Cooling in Evaporation, Condensation, and Crystallization (Pages 111, 116, 135 Q3): Heating by the Sun causes surface water to absorb thermal energy and evaporate into rising water vapor. As moist air rises high into the atmosphere, cooling causes water vapor to lose thermal energy and condense into liquid cloud droplets (condensation) or freeze into six-sided ice crystals when temperatures are at or below 0°C (crystallization). (3) Daily-Life Examples Connected to the Water Cycle (Page 103, What happened to the puddle?): When a rain puddle disappears on a sunny day, thermal energy from sunlight warms the liquid water so it evaporates into invisible water vapor in the atmosphere—the exact same process that lifts ocean water into the sky to form clouds and rain.

Key Ideas from the Student Book:

• Lesson Launch (Page 103): The puddle disappeared because liquid water absorbed thermal energy from the Sun and evaporated into invisible water vapor in the air.

• Three-Dimensional Thinking (Page 111): Heating speeds up surface water molecules until they break away as gas (evaporation).

• Three-Dimensional Thinking (Page 135 Q3): The complete water-cycle model shows how heating (evaporation/transpiration) and cooling (condensation/crystallization) cycle water continuously.

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State Change Process	States Involved	Heating or Cooling (Energy Change)	Connection to Daily Life & Water Cycle
Melting	Solid → Liquid	Heating (Thermal energy ABSORBED)	Snow/glaciers melting in sunlight to feed rivers and runoff
Evaporation	Liquid → Gas (at surface)	Heating (Thermal energy ABSORBED)	Rain puddle disappearing on a sunny sidewalk (Page 103); ocean water rising into air
Condensation	Gas → Liquid	Cooling (Thermal energy RELEASED)	Dew on grass, drops on a cold cup, bathroom mirror fogging, clouds forming in sky
Freezing / Crystallization	Liquid → Crystalline Solid	Cooling (Thermal energy RELEASED)	Water freezing into ice cubes; cloud droplets crystallizing into six-sided snowflakes

Remember:

✓ Heating (+ Thermal Energy) → Melting (Solid → Liquid) & Evaporation (Liquid → Gas).

✓ Cooling (– Thermal Energy) → Condensation (Gas → Liquid) & Freezing / Crystallization (Liquid → Solid).

✓ Disappearing Puddle = Evaporation driven by solar thermal energy.

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Questions :

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.

Question 1: Explain your reasoning and connect what happened to Earth's water cycle.

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Question 2: On the figure above, model the process that changes liquid water to water vapor. Label the transfer of energy that takes place during this process.

Also describe how heating and cooling cause melting, freezing, evaporation, condensation, and crystallization.

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Question 3: Which pathway of processes would explain how a water molecule from the stream could end up in an ice sheet?

(A) evaporation, transpiration, condensation, crystallization

(B) evaporation, crystallization, precipitation, condensation

(C) evaporation, respiration, crystallization, transpiration

(D) evaporation, condensation, crystallization, precipitation"

Question 4: did the water in the puddle vanish from existence, soak into solid concrete, or change state?

Question 5: Explain at the particle level what happens when sunlight shines on the surface of a puddle

Question 6: How does melting differ from evaporation in terms of the states of matter involved?

Question 7: What do melting and evaporation have in common in terms of thermal energy?

Question 8: How does condensation differ from crystallization (freezing)?

Question 9: What do condensation and crystallization have in common in terms of thermal energy?

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Q24 : Module 1 (Lesson 3) & Module 3 (Lessons 1 & 3)

Thermal Energy Transfers · Solar Energy on Earth · Weather Patterns

1) Identify the Sun as the main energy source.

2) Describe how solar energy heats Earth's surface and air.

3) Use simple weather data to identify patterns and changes in weather conditions.

4) Describe heating of Earth's surface and air - Explain unequal heating across Earth.

(Pages 65 , 160 , 213 , 216)

Free Response Questions - FRQ

Structured Concept Explanation (Earth Science Connection (Page 65) · Fronts (Page 213) · Change in Weather at Frontal Boundaries (Page 216) · Three-Dimensional Thinking (Page 160) · Page 65, Page 160, Page 213, Page 216):

This Free Response item connects solar radiation, unequal heating of Earth, and weather fronts: (1) The Sun as Main Energy Source & Heating Earth's Surface and Air (Page 65): The Sun is the main source of energy for Earth's atmosphere, water cycle, and weather. Solar energy travels 150 million km through the vacuum of space by radiation. Earth's surface (land and water) absorbs this solar radiation and warms up, then transfers thermal energy to the air above it by conduction (direct contact) and convection (rising warm air). (2) Unequal Heating Across Earth (Page 160, Three-Dimensional Thinking): Because Earth's surface is curved, a beam of sunlight striking near the poles (Beam A) hits at a low angle and spreads over a large area (less intense heating, colder), whereas an equal beam striking near the equator (Beam B) hits at a nearly 90° angle and concentrates on a small area (more intense heating, warmer). Land and water also heat unequally due to specific heat. (3) Weather Fronts & Weather Data (Pages 213 & 216): Unequal heating creates warm and cold air masses. A weather front is the boundary where two air masses of different temperatures and densities meet. At a Cold Front, a fast-moving cold, dense air mass wedges under a warm air mass, lifting it rapidly to cause cumulous/cumulonimbus clouds, heavy rain/thunderstorms, gusty winds, and a sharp drop in temperature followed by clear, cooler weather. At a Warm Front, a warm air mass slides gently up over a retreating cold air mass, bringing wide layers of stratus clouds, steady light rain, and warmer, more humid air after passing. Stationary fronts bring days of cloudy, wet weather, while occluded fronts trap warm air aloft between two cooler air masses.

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Key Ideas from the Student Book:

• Earth Science Connection (Page 65): The Sun is the primary source of thermal energy on Earth, transferring energy across space by radiation.

• Three-Dimensional Thinking (Page 160): Beam B at the equator hits at ~90° (concentrated over a smaller area = warmer), while Beam A near the poles hits at a low angle (spread over a larger area = colder).

• Fronts & Weather Data (Pages 213 & 216): If weather data show a sudden drop in temperature (e.g., 28°C → 16°C) with brief heavy thunderstorms followed by clearing skies, a Cold Front has passed. If temperature rises gradually with steady light rain, a Warm Front has passed.

Type of Weather Front (Pages 213 & 216)	How Air Masses Move	Weather Changes & Conditions
Cold Front (Blue line with triangles)	Cold, dense air advances rapidly and pushes warm air sharply upward	Sudden drop in temperature, gusty winds, heavy rain or thunderstorms (cumulonimbus clouds), followed by cooler, clearer weather
Warm Front (Red line with semicircles)	Warm, less dense air advances and slides gradually up over cold air	High cirrus then stratus clouds, steady light-to-moderate rain/snow, followed by warmer and more humid weather
Stationary Front (Alternating red/blue)	Cold and warm air masses meet, and neither advances (stalled)	Many days of cloudy skies and prolonged, steady precipitation
Occluded Front (Purple line)	A fast cold front overtakes a warm front, lifting the warm air completely off the ground	Strong winds and heavy precipitation as warm air is pushed aloft

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Remember:

✓ Main Energy Source = The Sun (transfers energy to Earth by Radiation; surface warms air by Conduction & Convection).

✓ Unequal Heating (Page 160) = Equator receives direct 90° rays (small area, hot); Poles receive slanted low-angle rays (large area, cold).

✓ Cold Front = Cold air pushes warm air up rapidly → Thunderstorms / heavy rain + Sudden temperature DROP.

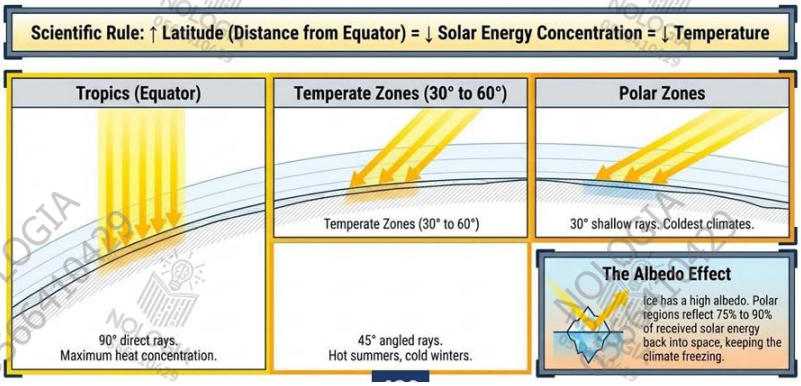
✓ Warm Front = Warm air slides over cold air → Steady light rain + Temperature RISE.

The Foundation: Weather vs. Climate

WEATHER	CLIMATE
• Definition: The condition of the atmosphere at a particular place and time.	• Definition: The average weather in a region over a long period of time.
• Timeframe: Short-term (hours, days).	• Timeframe: Long-term (years, decades).
• Key Factors: Temperature, rainfall, wind speed, wind direction.	• Key Factors: Variation of global factors (latitude, altitude, oceans).
• Example: A cool, rainy, and windy morning.	• Example: Mild winters with little snow.

Scientific Principle: Climate is the long-term pattern that dictates the daily weather.

Ingredient 1: Solar Energy & Latitude

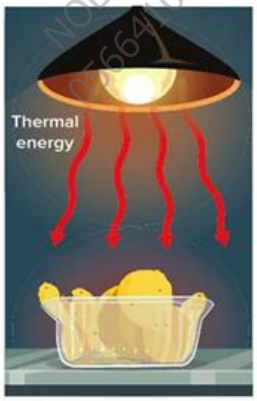


Ingredient 4: Ocean Currents

The Current Rule: Solar energy drives ocean convection.
Surface current temperature + prevailing winds = regional climate change.

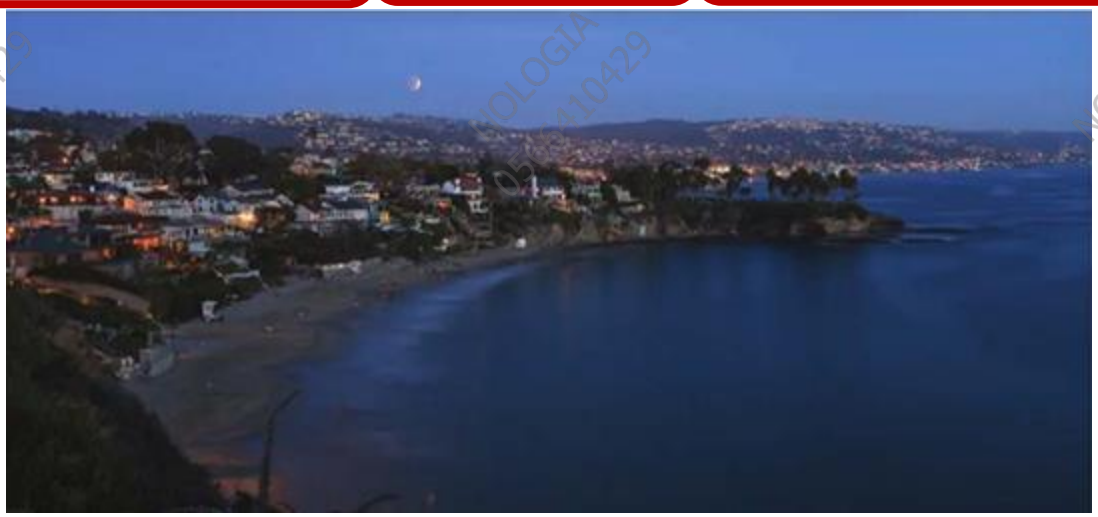


Questions :



Question 1: Identify the main energy source for Earth's atmosphere and weather, and describe how solar energy travels to Earth and heats both Earth's surface and the air above it.

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Question 2: 1. Now suppose you go back to the same beach at night. Explain the rate at which thermal energy is released by the water, sand, and air.

2. Draw arrows on the picture to show the direction of thermal energy flow at the beach during the day and at night.

3. Explain how the unequal heating of Earth's surface affects the atmosphere."

Question 2: Complete the Cold Front and Warm Front tables and answer Collect Evidence: "How does the interaction of air masses cause changes in weather conditions?"

Weather Factor	Cold Front (Before → During → After)	Warm Front (Before → During → After)
Temperature		
Air Pressure & Winds		
Clouds & Precipitation		

Question 3: What is the main source of energy that drives Earth's weather, winds, and water cycle?

Question 4: By which method of heat transfer does energy travel from the Sun through space to Earth ?

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Question 5: Does sunlight heat the atmosphere mostly from the top down or from the bottom up? Explain how.

Question 6: Why is the equator much warmer than the North and South Poles ?

Question 7: What is a "weather front" ?

Question 8: Why does the warm air mass always rise above the cold air mass when two air masses meet at a front?

Question 9: Describe what happens at a COLD front and what weather it brings.

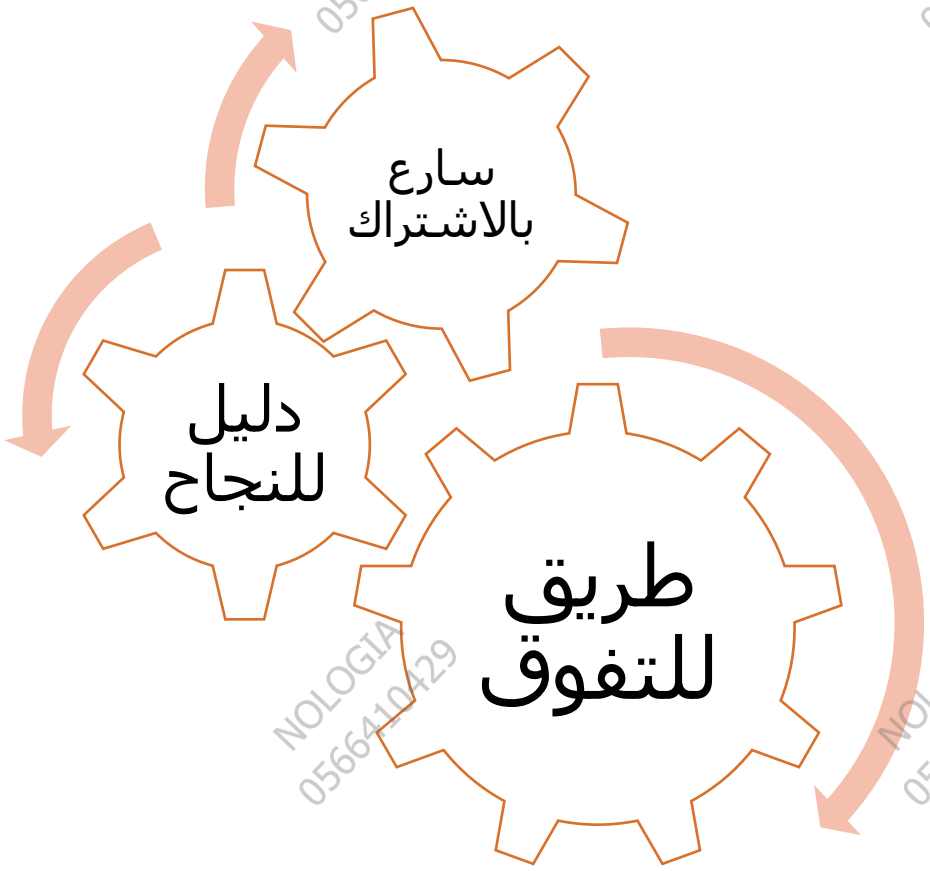
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Question 10: Describe what happens at a WARM front and what weather it brings.

Question 11: What is a "stationary front," and what kind of weather does it cause?

Question 12: What is an "occluded front"?

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