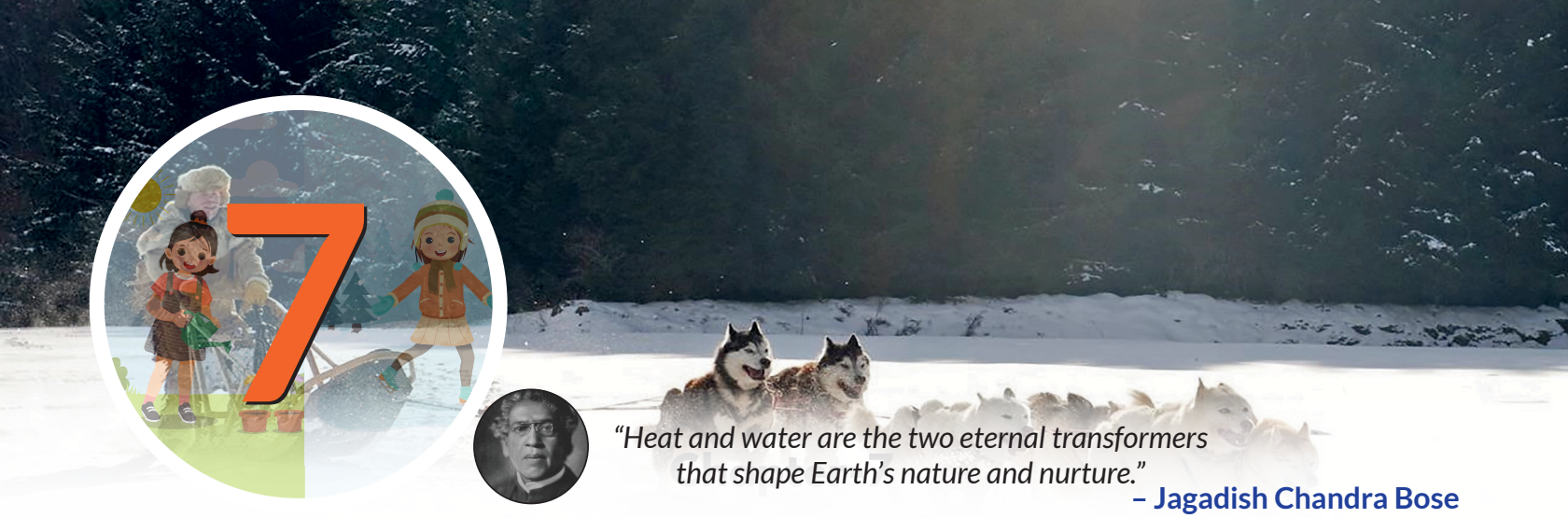


7

"Heat and water are the two eternal transformers that shape Earth's nature and nurture."

– Jagadish Chandra Bose

Heat Transfer in Nature and the Water Cycle

The Big Question

Why do we shiver in winter and sweat in summer? How does a tiny seed grow into a giant tree? From the warmth of a blanket to the sea breeze and falling rain, everyday wonders are guided by the science of heat transfer and the water cycle. These invisible forces silently shape our weather, support life, and drive nature's balance. Let's explore how they work all around—and within—us!

Meet EeeBee.AI

Hello, young scientists! I'm EeeBee, your curious companion. Join me as we explore how heat moves and how water travels across Earth. Get ready to observe, question, and discover the wonders of science together!

Still curious? Talk to me by scanning the QR code.

Learning Outcomes

By the end of this chapter, students will be able to:

- The role of heat transfer in everyday life, including clothing choices and house design.
- How water seeps into the Earth's surface and forms groundwater.
- The importance of groundwater and methods for its replenishment.
- Your understanding of heat transfer and the water cycle to explain various natural phenomena and human adaptations

From Last Year's Notebook

- The Science of Water
- Evaporation and Its Role in Nature
- Transformation of Water States

Science Around you

Why is Chennai more humid than Delhi? How do people in Ladakh store water using ice stupas? These real-life examples show how heat transfer and the water cycle shape climates, affect daily life, and inspire smart solutions. Understanding these natural processes helps us value Earth's balance and make better choices for our environment and future.

NCF Curricular Goals and Competencies

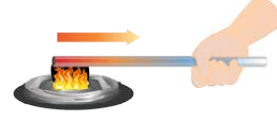
CG 7.1 – Understand conduction, convection, and radiation as methods of heat transfer. **CG 7.2** – Relate natural phenomena like land and sea breezes to heat transfer processes.

Mind Map

Heat Transfer in Nature and the Water Cycle

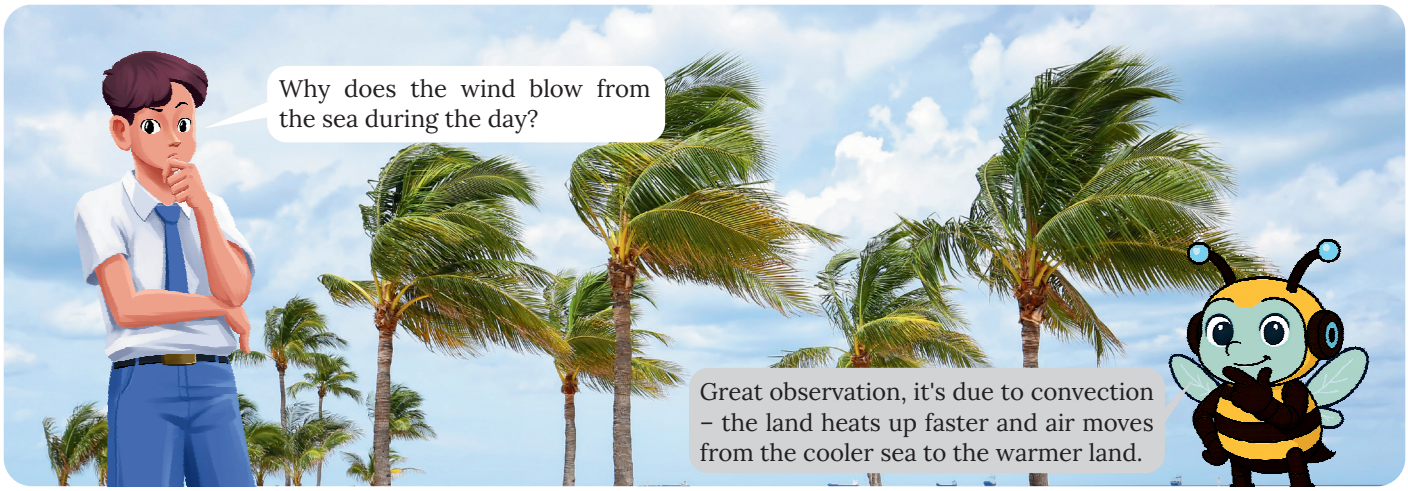
Transfer of Heat

- **Definition:** Heat = energy moves from hot → cold.
- **Modes of Heat Transfer:**
- **Conduction:** Heat transfer by vibrating particles in solids.
  - ✓ **Good conductors:** metals (copper, aluminium).
  - ✓ Poor conductors (insulators): wood, air.
  - ✓ **Example:** Cooking pan handle gets hot.
- **Convection:** Transfer in liquids & gases by fluid movement.
  - ✓ Warm fluid rises (less dense), cool sinks (more dense).
  - ✓ **Examples** → Sea breeze (day), Land breeze (night), boiling water.
- **Radiation:** Transfer by electromagnetic waves; no medium needed.
  - ✓ Sun's heat to Earth.
  - ✓ **Example** → Feeling fire's heat without touching.
- **Applications:**
  - ✓ Woollen clothes trap air (insulation).
  - ✓ Hollow bricks for house insulation.
  - ✓ **Cooking utensils** → metals (good conductors).



Water Cycle

- **Definition:** Continuous movement of water on, above & below Earth, driven by Sun + gravity.
- **Processes:**
  - ✓ **Evaporation** – water → vapour from oceans, lakes, rivers.
  - ✓ **Transpiration** – evaporation of water from plant leaves .
  - ✓ **Condensation** – vapour cools → droplets/ice → clouds .
  - ✓ **Precipitation** – rain, snow, hail, sleet falls to Earth .
  - ✓ **Collection/Runoff** – water gathers in oceans, rivers, lakes.
  - ✓ **Infiltration** – water seeps into ground through soil & rocks.
  - ✓ **Groundwater** – stored water beneath Earth in aquifers.
- **Importance:**
  - ✓ Redistributes & replenishes freshwater.
  - ✓ Essential for ecosystems & human survival.
  - ✓ Sustainable management needed → rainwater harvesting.



In Focus

- Transfer of Heat
- Water Cycle

Introduction

Transfer of heat refers to the movement of thermal energy from a region of higher temperature to a region of lower temperature. This natural process occurs in various ways and is essential in both natural and man-made systems. It plays a vital role in our daily lives, from warming our homes to cooking food. Heat can be transferred in three main ways: conduction, convection, and radiation, each occurring through different mechanisms and materials.

From History's Pages

The scientific study of heat transfer began in the 18th century with Joseph Black's work on latent heat. In the early 19th century, Fourier introduced mathematical models for heat conduction. James Prescott Joule's experiments (1840s) linked heat and energy, forming the basis of thermodynamics. The water cycle's modern understanding emerged in the 17th and 18th centuries, but satellite observations in the 20th century greatly advanced knowledge. Today, heat transfer and the water cycle are key in climate science, weather forecasting, and environmental studies, supported by data from organizations like NASA and the World Meteorological Organization.

Transfer of Heat

Conduction is the process of heat transfer in solids, where thermal energy moves from a hotter region to a cooler one without the movement of matter. Imagine a line of people passing a bucket—each stays in place but transfers the bucket to the next. Similarly, in conduction, vibrating particles transfer energy to adjacent particles.When one end of a solid is heated, its particles gain **kinetic energy** and vibrate faster. These vibrations are transferred through direct contact to neighbouring particles, gradually spreading heat across the material. In metals, free electrons enhance conduction by carrying heat efficiently.

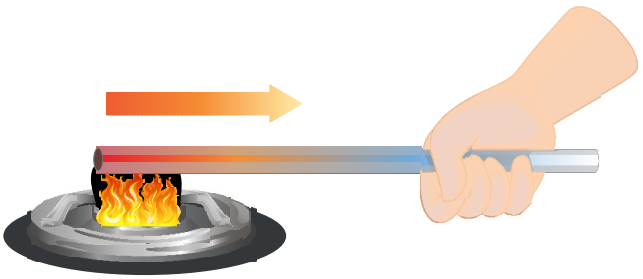


Fig. 7.1 Heat Transfer in Solid

Keywords

Kinetic energy : It is the energy an object has due to its motion. The *faster an object moves, the more kinetic energy it has.*

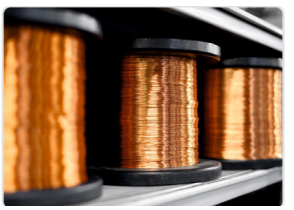
Examples:

- Heating one end of a metal spoon causes the other end to become hot.
- Touching a stove results in heat conducting from the surface to your hand.
- Metal pot handles get hot while cooking.

Conductors and Insulators

Good conductors (e.g., copper, aluminium) allow heat to pass quickly, used in utensils.

Silver



Copper

Aluminum

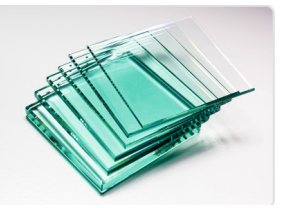
Iron

Fig. 7.2 Conductors

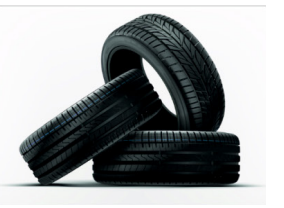
Insulators (e.g., wood, plastic, wool) resist heat flow, used in handles and clothing.

Wood

Plastic



Glass



Rubber

Fig. 7.3 Insulators

Examples:

- Metal cooking pots are good conductors.
- Wooden/plastic handles prevent burns.
- Air in wool traps heat.

Convection: Heat Transfer in Liquids and Gases

Convection involves heat transfer through the actual movement of fluid particles. When heated, fluid becomes less dense and rises. Cooler fluid then moves in to take its place, creating a convection current.

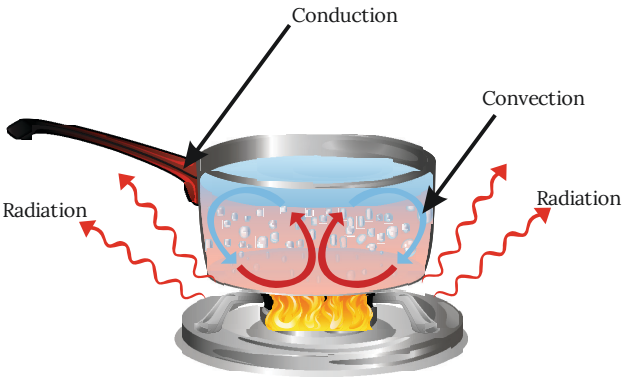


Fig. 7.4 Convection

Examples:

- Boiling water circulates heat.
- Sea and land breezes.
- Room heaters warming air.

Fig. 7.5 Sea, Land Breeze and Room Heaters

Radiation: Heat Transfer Without a Medium

Radiation is the transfer of heat via electromagnetic waves (mainly infrared), requiring no medium. It's how Earth receives heat from the Sun.All objects emit radiation above absolute zero. Hotter objects emit more energy. When this radiation hits another surface, it can be absorbed, increasing its temperature.

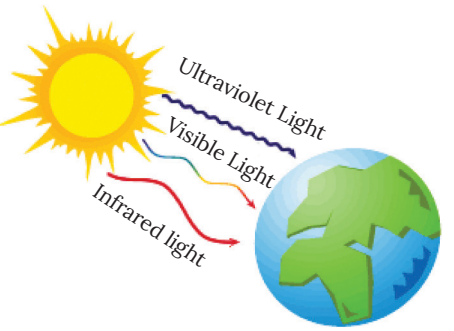


Fig. 7.6 Radiation

Examples:

- Sun warming the Earth.
- Feeling heat from a bonfire.
- Heat from a light bulb.

Applications and Examples

Cooking Utensils

- Metal pans conduct heat efficiently for cooking.
- Plastic/wood handles prevent burns.

Woollen Clothing

Trapped air in wool insulates the body by limiting conduction and convection.

Land and Sea Breezes

- **Day:** Land heats faster, hot air rises, sea air flows in—sea breeze.
- **Night:** Land cools faster, warm sea air rises, land air flows out—land breeze.

Fireplace Warmth

Radiation from fire heats you directly without heating the air in between.

Thermos Flask

- Prevents conduction and convection with a vacuum.
- Minimizes radiation with shiny inner walls.

Common Misconceptions

× **Misconception:** Cold is a substance that moves into objects.
✓ **Correction:** Cold is not a substance; it is merely the absence or lower level of heat energy. Heat always flows from warmer objects to colder objects. When something feels cold, it means heat is flowing **out** of your hand **into** the object.

× **Misconception:** Woollen clothes "produce" heat to keep us warm.
✓ **Correction:** Woollen clothes do not produce heat. They are good insulators because they trap a layer of air between their fibres. This trapped air is a poor conductor of heat, which significantly reduces the rate at which your body heat escapes to the colder surroundings. They **prevent** heat loss, rather than generating heat.

× **Misconception:** Convection only occurs when a fluid is heated from below.
✓ **Correction:** While heating from below is a common way to initiate convection, it can also occur when a fluid is cooled from above (e.g., cold air sinking). The key is a density difference caused by temperature variations, leading to fluid movement.

Science Around You

Thermal insulation in homes (e.g., double-glazed windows, insulated walls) uses trapped air or other poor conductors to reduce heat loss in winter and heat gain in summer, saving energy and reducing electricity bills.

Activity

Investigating Conduction in Different Materials

- **Objective:** To compare the thermal conductivity of different materials.
- **Materials Required:** A metal rod (e.g., aluminium or copper), A glass rod, A wooden stick, Small pins or thumbtacks, Wax (e.g., from a candle), A stand with a clamp (or two bricks for support), A spirit lamp or candle, Stopwatch
- **Procedure:**
  1. Take the metal rod, glass rod, and wooden stick, ensuring they are of similar length and thickness.
  2. Attach three small pins to each rod using small amounts of wax, spacing them equally (e.g., 2 cm apart) along the length of the rod. Label the pins on each rod as 1, 2, 3 starting from one end.
  3. Secure one end of each rod in a stand (or support between bricks) so that the other end is free.

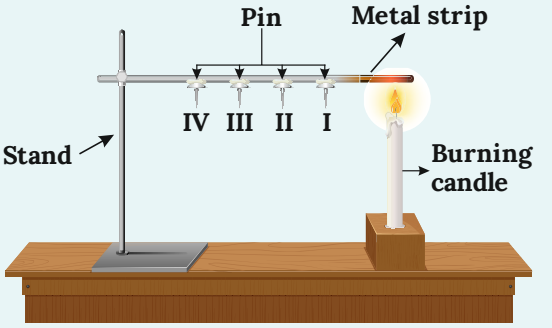


Fig. 7.7 Heat transfer in a metal strip

  4. Simultaneously heat the free end of each rod with a spirit lamp or candle flame. Ensure the flame is applied consistently to all three rods.
  5. Observe the order in which the pins fall from each rod. Record the time it takes for each pin to fall (metal spoon). If the bulb glows, the object is a conductor. If it doesn't, it's an insulator.
- **Observation:**

  Which rod's pins fall first? Which last?

  What does the order of pins falling tell you about the material's ability to conduct heat?

Knowledge Checkpoint

Gap Analyzer™ Homework | Watch Remedial

Multiple Choice Questions:

Remembering

1. **Which of the following materials is the best conductor of heat?**

   a) Wood ☐ b) Plastic ☐

   c) Copper ☐ d) Air ☐

2. **Which mode of heat transfer does not require a medium?**

   a) Conduction ☐ b) Convection ☐

   c) Radiation ☐ d) All of the above ☐

Applying

3. Why does smoke rise from a burning fire?

a) Smoke particles are naturally lighter than air. ☐

b) The hot smoke and air become less dense and rise. ☐

c) Smoke is pushed upwards by the fire. ☐

d) Smoke is attracted to the sky. ☐

Analyzing

Short Answer Question:

4. Explain why the handle of a metal cooking pot is often made of wood or plastic.

5. Describe how a sea breeze forms during the day.

Evaluating

Long Answer Question:

6. Discuss the three modes of heat transfer, providing a distinct real-world example for each. Explain how each example demonstrates its respective mode of heat transfer.

Water Cycle

Water is essential for all known forms of life on Earth. It covers about 71% of the Earth's surface and exists in three states: solid (ice), liquid (water), and gas (water vapour). But where does all this water come from, and how does it move around our planet? The answer lies in a continuous, never-ending journey called the **water cycle**, also known as the hydrological cycle. This cycle describes the constant movement of water above, on, and below the Earth's surface. It's a fundamental process that redistributes water, replenishes freshwater sources, and plays a crucial role in regulating Earth's climate. Understanding the water cycle helps us appreciate the interconnectedness of Earth's systems and the importance of water conservation. In this section, we will explore the key processes that drive this vital cycle.

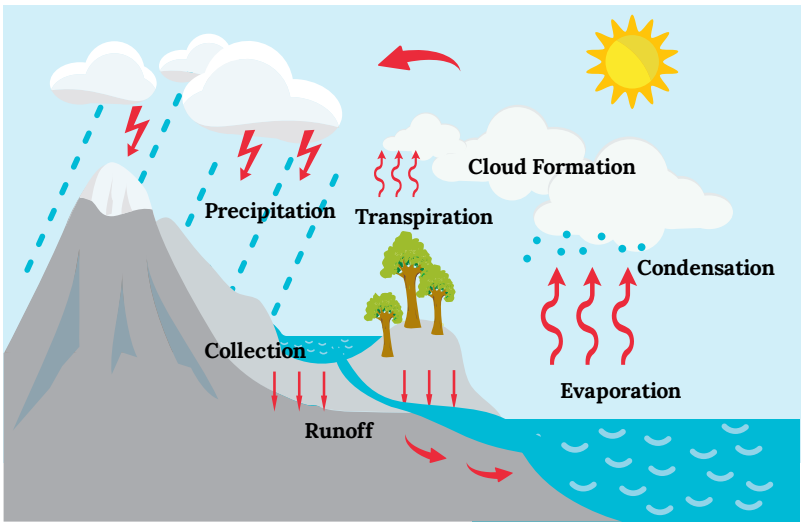


Fig. 7.8 Water Cycle

Evaporation

Evaporation is a crucial step in the water cycle, describing the transformation of liquid water into water vapour, a gaseous state. This process occurs when water molecules on the surface of oceans, lakes, rivers, or even moist soil absorb enough heat energy—primarily from the sun—to break the intermolecular bonds holding them in the liquid phase. Once they gain sufficient kinetic energy, these molecules escape into the air as water vapour. Evaporation can occur at any temperature, unlike boiling which happens at a specific point. Factors such as higher temperatures, lower humidity, increased wind speed, and larger surface areas significantly increase the rate of evaporation.

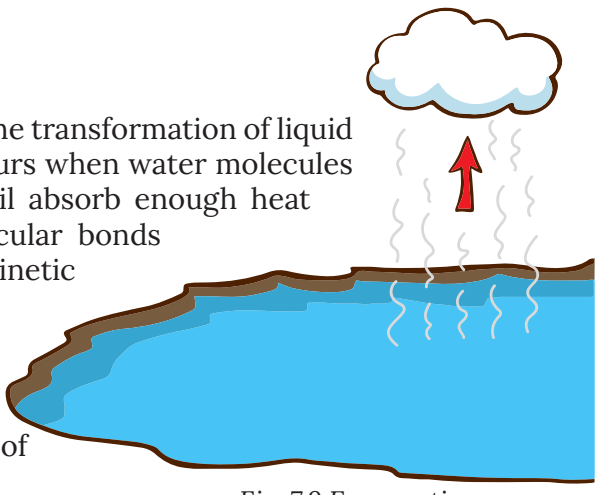


Fig. 7.9 Evaporation

Transpiration

Transpiration is the process by which plants release water vapour into the atmosphere through tiny pores called stomata, typically found on the underside of leaves. Water absorbed by the roots travels through the plant's vascular system to the leaves, where it is then lost as vapour. This biologically driven process, powered by solar energy, contributes significantly to atmospheric moisture, particularly in regions with dense vegetation like tropical rainforests.

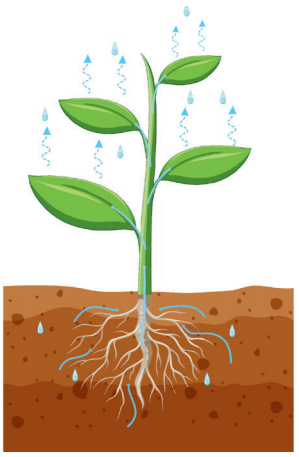


Fig. 7.10 Transpiration

Condensation

Condensation is the process through which water vapour in the atmosphere cools down and transforms back into tiny droplets of liquid water. This typically occurs when the warm, moist air rises and cools in the upper atmosphere. These droplets often form around microscopic dust or salt particles known as condensation nuclei. As they cluster together, they form clouds, fog, or dew, depending on conditions.

Precipitation

Precipitation is the mechanism by which condensed water in clouds becomes too heavy to remain airborne and falls to Earth due to gravity. Depending on atmospheric temperatures, this can manifest as rain, snow, sleet, or hail. Precipitation is vital for replenishing surface water and groundwater resources.

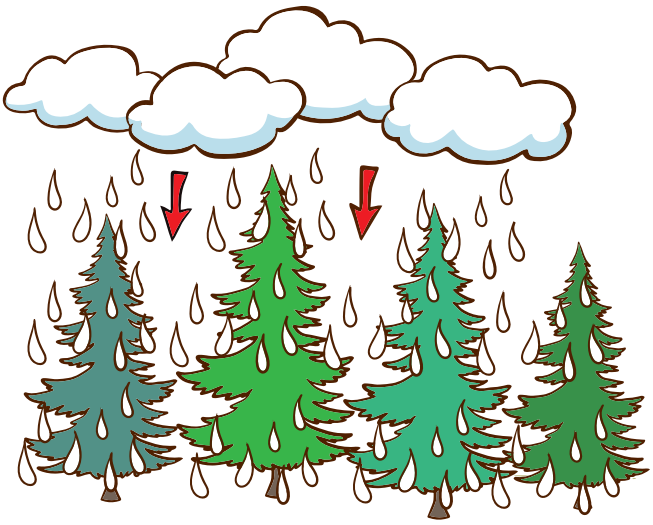


Fig. 7.11 Condensation

Collection and Runoff

After precipitation, the water reaches the Earth's surface and either collects in natural reservoirs such as lakes, ponds, rivers, and oceans, or flows over land as runoff. Runoff water contributes to the movement of nutrients and sediments and plays a role in shaping the landscape through erosion.

Applications and Examples

Drying Clothes (Evaporation)

- Wet clothes dry faster under the sun due to the heat energy aiding in the evaporation of water molecules from the fabric.

Formation of Dew (Condensation)

- On cool mornings, surfaces like grass and cars cool the nearby air, causing water vapour to condense into dew droplets.

River Flow and Dams (Collection)

- Rivers gather runoff water from rain and melting snow. Dams store this water in reservoirs for irrigation, power generation, and drinking purposes.

Keywords

Irrigation: It is the process of supplying water to crops through artificial methods. It helps plants grow in areas where there is not enough rainfall.

Groundwater Extraction (Infiltration)

- Rainwater seeps through soil into underground reservoirs called aquifers. Wells and boreholes tap into these aquifers to supply water.

Rainforests and Local Climate (Transpiration)

- Dense forests contribute large amounts of water vapour through transpiration, increasing local humidity and promoting frequent rainfall, thereby sustaining the ecosystem.

Fact Flash

At any given moment, about 12,900 cubic kilometers of water is circulating in the atmosphere as water vapour—enough to fill 5 billion Olympic-sized pools floating invisibly above us!

Common Misconceptions

× **Misconception:** The water cycle is a linear process, starting with evaporation and ending with collection.

✓ **Correction:** The water cycle is a continuous cycle with no true beginning or end. Water can enter or exit any stage at any time. For example, water can evaporate from a lake, condense into a cloud, precipitate as rain, and then immediately evaporate from a puddle, bypassing rivers or groundwater.

× **Misconception:** Clouds are made of steam or water vapour.

✓ **Correction:** Water vapour is an invisible gas. Clouds are visible because they are made of tiny, suspended liquid water droplets or ice crystals that have formed from condensed water vapour.

× **Misconception:** Groundwater is stored in underground rivers or lakes.

✓ **Correction:** While some underground caves can contain water, most groundwater is stored in the tiny pore spaces between particles of soil, sand, gravel, and in cracks and fractures within rocks, much like water in a sponge. These water-bearing layers are called aquifers.

× **Misconception:** All precipitation becomes runoff and flows into rivers.

✓ **Correction:** A significant portion of precipitation infiltrates the ground to become groundwater. Some also evaporates directly from surfaces, and some is absorbed by plants. The amount that becomes runoff depends on factors like soil type, vegetation cover, and intensity of rainfall.

Science Around You

The water cycle powers our daily lives—from drying clothes on a sunny day to getting fresh water through borewells. Forests like the Amazon release 20 billion tonnes of water daily via transpiration, influencing global rainfall. Without this natural recycling system, freshwater would run out quickly, affecting ecosystems, agriculture, and survival.

Activity

Observing Transpiration in Plants

- **Objective:** To demonstrate that plants release water vapour into the atmosphere.
- **Materials Required:** A healthy potted plant (with leaves), A clear plastic bag (large enough to cover a branch), String or rubber band, Sunlight
- **Procedure:**
  1. Choose a healthy branch of the potted plant that has several leaves.
  2. Carefully enclose the branch, including its leaves, within the clear plastic bag.
  3. Tie the opening of the plastic bag tightly around the stem of the branch with string or a rubber band, ensuring no air can escape or enter, but without damaging the plant.
  4. Place the potted plant in direct sunlight for a few hours.
  5. Observe the inside of the plastic bag.

Fig. 7.12 Materials Required

- **Observation:**

  What do you observe inside the plastic bag after a few hours? (Tiny water droplets will form on the inner surface of the bag).

  Where did this water come from? (It came from the plant).

  What process is demonstrated by this activity? (Transpiration).

Knowledge Checkpoint

Gap Analyzer™ Homework | Watch Remedial

Multiple Choice Questions:

Remembering

1. **Which process involves water changing from a liquid to a gas due to heat?**
   - a) Condensation ☐ b) Precipitation ☐
   - c) Evaporation ☐ d) Infiltration ☐
2. **What are clouds primarily made of?**
   - a) Water vapour ☐ b) Oxygen and Nitrogen ☐
   - c) Tiny liquid water droplets or ice crystals ☐ d) Dust particles ☐
3. **The process by which water seeps into the ground is called:**
   - a) Runoff ☐ b) Transpiration ☐
   - c) Precipitation ☐ d) Infiltration ☐

Short Answer Question:

Understanding

4. Explain the difference between evaporation and condensation in the water cycle.
5. How do plants contribute to the water cycle? Name the specific process.

Long Answer Question:

Analyzing

6. Describe the complete journey of a water molecule through the water cycle, starting from an ocean and ending back in the ocean. Include all major processes and their scientific explanations.

SUMMARY

Heat Transfer

- Heat is a form of energy that moves from hotter to colder regions.
- There are three primary modes of heat transfer:
- **Conduction:** Occurs mainly in solids, where heat is transferred by vibrating particles passing energy to adjacent particles without moving from their positions. Metals are good conductors, while materials like wood and air are poor conductors (insulators).
- **Convection:** Occurs in fluids (liquids and gases), where heat is transferred by the actual movement of heated particles. Warmer, less dense fluid rises, and cooler, denser fluid sinks, creating convection currents (e.g., land and sea breezes).
- **Radiation:** Heat transfer through electromagnetic waves, requiring no medium. This is how heat from the Sun reaches Earth. All objects emit and absorb thermal radiation.

Understanding heat transfer principles is vital for designing efficient clothing (e.g., woollen clothes trapping air), buildings (e.g., hollow bricks, insulation), and cooking utensils.

Water Cycle:

The water cycle is the continuous movement of water on, above, and below the Earth's surface, driven by solar energy and gravity.

Key processes include:

- **Evaporation:** Liquid water changes to water vapour (gas) and rises into the atmosphere, primarily from oceans, lakes, and rivers.
- **Transpiration:** Evaporation of water from plant leaves.
- **Condensation:** Water vapour cools and changes back into tiny liquid water droplets or ice crystals, forming clouds.
- **Precipitation:** Water (rain, snow, hail, sleet) falls from clouds to the Earth's surface.
- **Collection/Runoff:** Water accumulates in oceans, lakes, and rivers, or flows over land.
- **Infiltration:** Water seeps into the ground through soil and rock.
- **Groundwater:** Water stored beneath the Earth's surface in pore spaces and cracks, forming aquifers.

The water cycle ensures the redistribution and replenishment of freshwater resources, making it crucial for ecosystems and human survival. Groundwater is a vital resource, and its sustainable management, including rainwater harvesting, is essential.

Example Based Questions

Multiple Choice Questions

1. **Which method of heat transfer allows the Sun's heat to reach Earth?**

   (a) Conduction (b) Convection

   (c) Radiation (d) Reflection

   Answer: (c) Radiation

   Explanation: Radiation transfers heat without the need for a medium. The Sun's energy travels through the vacuum of space and warms the Earth.

2. **In which process of heat transfer does hot air rise and cool air take its place?**

   (a) Conduction (b) Convection

   (c) Radiation (d) Absorption

   Answer: (b) Convection

   Explanation: Convection occurs in liquids and gases. Hot air or liquid becomes lighter and rises, while cooler, denser air or liquid sinks, creating a cycle.

Short Answer Questions

3. **Why is the water cycle called a "never-ending process"?**

   Answer: The water cycle continuously circulates water through evaporation, condensation, precipitation, and collection. Water from oceans and lakes evaporates, forms clouds, falls as rain, and flows back to water bodies. This cycle keeps repeating endlessly, making it "never-ending."

4. **Explain why land gets heated faster than water during the day.**

   Answer: Land absorbs and releases heat quickly, while water takes more time to heat up and cool down. That is why during daytime, land becomes hotter than water, and at night water remains warmer for longer. This difference also causes land and sea breezes.

5. **Explain the three methods of heat transfer in nature with examples.**

   Answer: **1. Conduction:** Heat transfer through direct contact in solids. Example: Heat moving from the bottom of a metal pan to its handle.

   2. Convection: Heat transfer in liquids and gases by the movement of particles. Example: Warm air rising to form wind currents, or boiling water where hot water rises and cooler water sinks.

   3. Radiation: Heat transfer without a medium, directly through waves. Example: Sunlight reaching Earth, warming our skin on a sunny day.

   Conclusion: All three methods work together in nature—for example, sunlight heats Earth (radiation), the ground warms air (conduction), and air circulates (convection).

Long Answer Questions

6. **Describe the stages of the water cycle in detail. Why is it important for life on Earth?**

   Answer: **1. Evaporation:** Heat from the Sun turns water from oceans, rivers, and lakes into water vapour.

   2. Condensation: Water vapour rises, cools, and changes into tiny droplets, forming clouds.

   3. Precipitation: Water falls back to Earth as rain, snow, or hail when clouds become heavy.

   4. Collection: Rainwater collects in oceans, rivers, lakes, and underground reservoirs, restarting the cycle.

   Importance:

   - Provides freshwater for drinking and irrigation.
   - Maintains balance in nature.
   - Supports plant and animal life.
   - Controls climate and weather patterns.

   Conclusion: The water cycle is a continuous and essential natural process that sustains all life on Earth.

EXERCISE

Gap Analyzer™
Complete Chapter Test

A. Choose the correct answer.

1. Which form of heat transfer is primarily responsible for the evaporation of water from oceans and lakes?

   (a) Conduction ☐ (b) Convection ☐

   (c) Radiation ☐ (d) Absorption ☐

2. The process where warm, moist air rises and cooler, denser air sinks, leading to cloud formation, is an example of:

   (a) Conduction ☐ (b) Convection ☐

   (c) Radiation ☐ (d) Sublimation ☐

3. When water vapor changes into liquid water droplets to form clouds, it:

   (a) Absorbs latent heat ☐ (b) Releases latent heat ☐

   (c) Converts heat to light ☐ (d) Destroys heat energy ☐

4. Which of the following is an example of heat transfer by conduction in the water cycle?

   (a) Sun warming the ocean surface ☐

   (b) Warm air rising from the land ☐

   (c) Ice melting when it touches a warm rock ☐

   (d) Steam rising from a hot spring ☐

5. The energy that is absorbed or released when water changes its state (e.g., from liquid to gas) without a change in temperature is called:

   (a) Kinetic energy ☐ (b) Potential energy ☐

   (c) Thermal energy ☐ (d) Latent heat ☐

B. Fill in the blanks.

1. The primary source of energy for the entire water cycle is _____ from the Sun.
2. When water vapor cools down and turns back into liquid water droplets, the process is called _____.
3. Heat transfer by the movement of heated fluids (liquids or gases) is known as _____.
4. The process by which plants release water vapor into the atmosphere is called _____.
5. When ice melts into liquid water, it absorbs _____ heat from its surroundings.

C. Write True or False.

1. Conduction is the most significant mode of heat transfer in the global water cycle. ____
2. Condensation causes the surrounding air to warm up. ____
3. The amount of water on Earth continuously increases due to the water cycle. ____
4. Sublimation is the process where ice directly changes into water vapor. ____
5. Heat always flows from a cooler object to a warmer object. ____

D. Define the following terms.

1. Evaporation.
2. Condensation
3. Latent Heat
4. Convection Currents
5. Precipitation

E. Match the columns.

	Column A		Column B
1.	Sun warming ocean water	(a)	Latent heat release
2.	Rising warm, moist air	(b)	Convection
3.	Cloud formation	(c)	Radiation
4.	Melting snow	(d)	Latent heat absorption
5.	Heat from a campfire	(e)	Direct contact heat transfer

F. Assertion and Reason

Instructions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is NOT the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.
e) Both A and R are false.

1. **Assertion:** Evaporation of water from a wet surface causes a cooling effect.
   Reason: Water absorbs latent heat from the surroundings during evaporation.
2. **Assertion:** Clouds are formed due to the condensation of water vapor.
   Reason: Condensation of water vapor releases heat into the atmosphere.
3. **Assertion:** The Sun's energy is vital for the water cycle.
   Reason: Solar radiation directly drives the melting of glaciers.

G. Give reasons for the following statements.

1. Why does sweating help cool your body?
2. Why do clothes dry faster on a sunny, windy day than on a cloudy, still day?
3. Why do low-lying areas often experience fog in the early morning after a clear night?
4. Why are icebergs dangerous for ships, even though most of the ice is submerged?

H. Answer in brief.

1. Explain how solar radiation drives the initial steps of the water cycle.
2. What is the role of convection in atmospheric circulation and the water cycle?
3. Describe what happens to heat energy when water vapor condenses to form clouds.
4. How does the melting of snow and ice contribute to the water cycle and affect local temperatures?

I. Answer in detail.

1. Explain how conduction, convection, and radiation transfer heat in the water cycle, with one example for each.
2. Define latent heat and explain its importance during evaporation and condensation in the water cycle.
3. Describe the journey of water in the water cycle, identifying where heat is absorbed during evaporation and released during condensation.

SKILL-BASED PRACTICE

Activity Time

STEM

Cloud in a Bottle Experiment

Materials Needed: Large clear plastic bottle with a lid (e.g., 2-liter soda bottle), Warm water (about 1-2 inches at the bottom), Matches or a smoke source (adult supervision required!), Flashlight

Materials Required

Activity Steps:

- Pour about 1-2 inches of warm water into the bottle. Swirl it around to warm the inside walls.
- Light a match, let it burn for a second, then blow it out. Quickly drop the smoking match into the bottle and cap it tightly (adult supervision critical for this step). The smoke particles will act as condensation nuclei.
- Quickly and firmly squeeze the bottle, then release it. Repeat this several times (squeeze and release).
- Observe what happens inside the bottle with the help of a flashlight.

Questions to Answer:

1. What happened inside the bottle when you released the squeeze?
2. How does squeezing and releasing the bottle relate to the heat transfer and pressure changes that occur in the atmosphere to form clouds?
3. What was the role of the warm water and the smoke in this experiment?

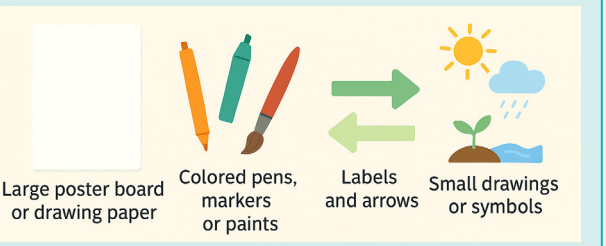
Skills Covered: Experimentation, Observation, Understanding atmospheric

Creativity

Art

Water Cycle Heat Transfer Diagram

Task: Create a detailed and colorful diagram illustrating the water cycle, specifically highlighting where each type of heat transfer (radiation, convection, conduction) and latent heat exchange occurs.



Materials Required

Materials: Large poster board or drawing paper, Colored pens, markers, or paints, Labels and arrows to indicate processes and heat flow, Small drawings or symbols for Sun, clouds, water bodies, plants, etc.

Questions to Answer:

1. How did you visually represent the different types of heat transfer (e.g., specific colors for different types of energy)?
2. Which parts of the water cycle did you emphasize as being most impacted by heat transfer?

Skills Covered: Creativity, Conceptual Understanding, Scientific Communication

Local Weather and Heat Transfer Observation

Group Activity

- **Activity Instructions:** Work in a group. Over three consecutive days, observe and record local weather conditions at different times of the day (morning, noon, evening).

  Note down:

  - Air temperature
  - Cloud cover
  - Wind presence/strength
- Any precipitation Discuss how these observations relate to heat transfer processes (e.g., how sunny conditions relate to radiation/evaporation, how strong winds indicate convection/advection).

Questions:

1. How did the temperature change throughout the day, and which heat transfer process explains this?
2. Did you observe any cloud formation or dissipation? How do these relate to condensation/evaporation and heat release/absorption?
3. How did wind affect the feel of the temperature or the movement of clouds? Which heat transfer process does wind represent?

Skills Covered: Observation, Data Recording, Analysis & Interpretation, Teamwork

The Disappearing Puddle

Case Study

Read the given passage below and answer the question:

It was a sunny morning after a heavy rain last night. A large puddle had formed on the school playground. By lunchtime, the puddle had almost completely disappeared. A student, Rohan, wondered where all the water went. He also noticed that the asphalt around the puddle felt quite warm when the sun was shining, but the puddle itself, while shrinking, didn't feel scorching hot.

Guiding Questions for Analysis:

1. What process caused the puddle to disappear?
2. Which type of heat transfer from the Sun is primarily responsible for this process?
3. Why did the asphalt feel hot, but the water in the puddle didn't feel as scorching, even though it was also absorbing heat? (Hint: Think about latent heat.)
4. If it had been a cloudy day with no wind, would the puddle have disappeared faster or slower? Why?
5. What happens to the water that "disappeared" from the puddle? Where does it go?

Skills Covered: Observation, Questioning, Hypothesis Formation, Scientific Thinking, Inquiry Skills

Source Based Question

Source Passage (Yale Study, Nature, December 2024):

Recent research by Yale University scientists has revealed that **atmospheric rivers**—long, narrow bands of moisture traveling from the tropics—carry not only massive amounts of water vapor but also significant **heat**, which can influence surface temperatures. These "rivers in the sky" sometimes carry up to 15 times the water of the Mississippi River and can trigger intense rainfall. The study found a strong link between periods when more moisture is transported aloft and the onset of heatwaves at ground level. Researchers suggest that tracking the moisture content in these atmospheric rivers could provide valuable clues for predicting heatwaves—since moisture and heat often travel together in mysterious ways.

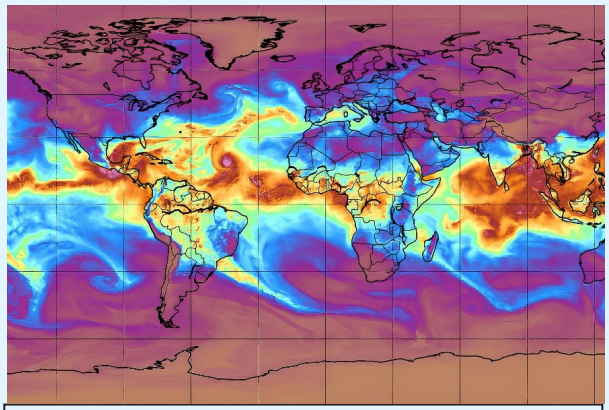

YaleNews

Across Yale: Yale's Impact on America Yale @ Climate Week NYC Architecture Lectures

Environment

Intense ribbons of rain also bring the heat, Yale scientists say

Yale researchers find that atmospheric rivers may be one cause of warmer winters in many parts of the world.



This map shows how much water vapor is present in the air on a day in October 2024. It also shows atmospheric rivers—long, narrow bands of moist air that move from warm tropical areas to cooler regions.

Image Credit: NaleNews

Guiding Questions for Analysis:

1. **Understanding Heat Transfer and Water in the Atmosphere**
   a. What phenomenon does the passage describe that involves both water and heat?
   b. Why does the passage say that the moisture in atmospheric rivers also brings heat?
2. **Cause and Consequence**
   a. How can moisture in the air affect temperatures on the ground?
   b. Why might understanding these atmospheric rivers help us predict heatwaves?
3. **Critical Thinking**
   a. Think of everyday examples where moisture (like steam or humidity) affects heat. Can you explain how that works?
   b. Why do you think scientists want to know how atmospheric rivers change over time in a warming world?

Skills Covered: Scientific observation and reasoning, Analysis, Understanding , Application