7

"In nature, nothing is constant. Everything is in a state of change." – Heraclitus

Temperature and Its Measurement

The Big Question

Imagine a hot summer day where your ice cream melts in minutes or a freezing winter morning when your breath turns into mist. What's really happening in these moments? The answer is temperature — a hidden force that controls how hot or cold things are. But how do we measure it? And why do different places feel so different in temperature, even at the same time? From simple thermometers to advanced weather tools, this chapter will uncover how we measure temperature, understand its effects, and explore its role in our daily lives and across the world.

Meet EeeBee.AI

Hello, curious temperature-takers! I'm EeeBee, your AI buddy. Let's explore temperature—what it is, how it's sensed—and learn about thermometers and scales!

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

Learning Outcomes

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

- Understand the three primary states of water and their characteristics.
- Identify the factors that influence the rate of evaporation in different scenarios.
- Comprehend how evaporation plays a role in cooling mechanisms.
- Explore the formation of clouds and learn about the water cycle's role in providing rainfall.

From Last Year's Notebook

- Measurement (Measuring Temperature)
- Measurement of Time and Temperature

Science Around you

Temperature is a constant presence in our lives. From cooking food safely and monitoring our body's health to predicting weather patterns and designing materials for extreme environments, its measurement is crucial. Understanding temperature helps us manage comfort, prevent spoilage, diagnose illness, and even innovate technologies that operate under varying thermal conditions.

NCF Curricular Goals and Competencies

CG-4 (C 4.1, 4.2, and 4.3) explores the concept of temperature, its measurement techniques, and its significance in understanding environmental and scientific phenomena.

Mind Map

Temperature and Its Measurement

Temperature

Measure of the hotness or coldness of an object or environment Determines the direction of heat flow (from hot to cold)

- ❖ **Temperature Scales**
- ✓ **Celsius (°C):** Based on the freezing (0°C) and boiling points (100°C) of water
- ✓ **Fahrenheit (°F):** Based on the freezing point of water (32°F) and boiling point (212°F)
- ✓ **Kelvin (K):** Absolute scale, starting at absolute zero (0 K)Same size degree as Celsius but no negative values
- ❖ **Relationship Between Celsius and Fahrenheit**
- ❖ **Formula:**

$$^\circ F = \frac{9}{5} \times {}^\circ C + 32$$

- ❖ **Relationship Between Celsius and Kelvin**
- ❖ **Formula:**

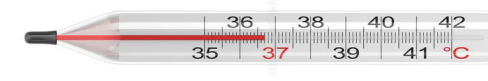
$$K = {}^\circ C + 273.15$$

Thermometer

Instrument used to measure temperature

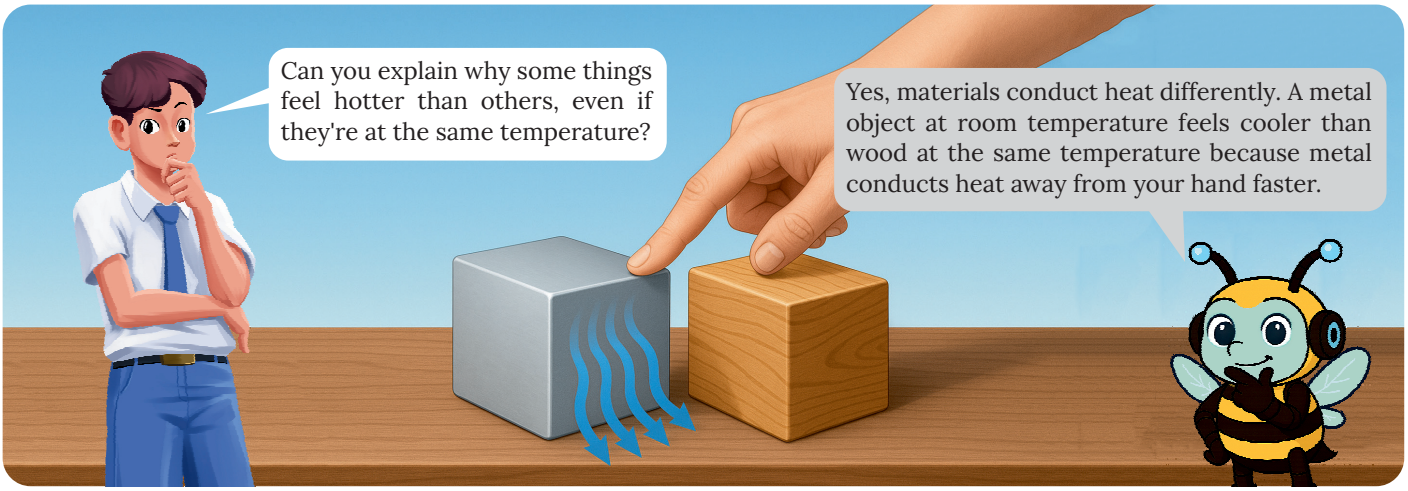
Types of Thermometer:

- ❖ **1. Clinical Thermometer**
  - ✓ Used to measure body temperature



- ❖ **2. Laboratory Thermometer(Image)**
  - ✓ Used to measure temperatures in laboratories
  - Temperature range: - 10°C to 110°C

- ❖ **Air Temperature**
  - ✓ Temperature of the atmosphere around us
  - ✓ Affects daily weather and climate
- ❖ **Seasonal Variations in Air Temperature**
  - ✓ Winter → Cold temperatures, lower angles of sunlight
  - ✓ Summer → Warm temperatures, higher angles of sunlight
  - ✓ Spring/Autumn → Transitional temperatures, moderate changes
  - ✓ Influenced by Earth's tilt, orbit, and seasonal changes in sunlight
  - ✓ Regional variations depending on latitude, altitude, and proximity to water bodies



In Focus

- Temperature
- Thermometer

From History's Pages

Early temperature measurement began with Galileo's thermoscope in the 17th century. Fahrenheit introduced the mercury thermometer and Fahrenheit scale in 1714, followed by Celsius's widely used scale in 1742.

Introduction

Temperature measures the hotness or coldness of a substance, reflecting the average kinetic energy of its particles. Thermometers, based on thermal expansion or electrical resistance, are essential for weather forecasting, industry, and medicine.

Temperature

Temperature is a fundamental concept that refers to the measure of how hot or cold a body is. It provides a quantitative way to express the degree of heat within a substance or object. A hotter body has a higher temperature compared to a colder one, signifying that it contains more thermal energy. This difference in thermal energy allows us to compare and determine the relative heat levels between two bodies. By measuring the temperature difference, we can analyze the heat transfer process, as heat naturally flows from a body with a higher temperature to one with a lower temperature. This concept is crucial in understanding various natural phenomena, from weather patterns to the behavior of substances as they undergo changes in state, such as melting, boiling, or freezing. Temperature also plays a vital role in daily life, influencing everything from our choice of clothing to the functioning of devices and machinery.

Temprature Scale

Temperature is measured using different scales, each designed for specific purposes. The three primary scales are Celsius, Fahrenheit, and Kelvin:

- **Celsius (°C):** This scale is widely used in scientific and everyday contexts. It defines the freezing point of water as 0°C and the boiling point as 100°C under standard atmospheric pressure.
- **Fahrenheit (°F):** Predominantly used in the United States, the Fahrenheit scale sets the freezing point of water at 32°F and the boiling point at 212°F.
- **Kelvin (K):** The Kelvin scale is the SI unit of temperature used in scientific research. It starts at absolute zero (0 K), the theoretical point where particle motion ceases. The freezing and boiling points of water are 273.15 K and 373.15 K, respectively.

These scales are interrelated through specific conversion formulas, allowing easy conversion between them.

Temperature Scale Table

Scale	Freezing Point of Water	Boiling Point of Water	Absolute Zero
Celsius (°C)	0°C	100°C	-273.15°C
Fahrenheit (°F)	32°F	212°F	-459.67°F
Kelvin (K)	273.15 K	373.15 K	0 K

Relationship Between Scales

- Celsius to Fahrenheit: $F = \left(\frac{}{5}\right)°C + 32$
- Fahrenheit to Celsius: $°C = \frac{5}{9}(F - 32)$
- Celsius to Kelvin: K = °C + 273.15
- Kelvin to Celsius: °C = K – 273.15

Practice Problems on Temperature Conversion

- Celsius to Fahrenheit (°C to °F):
- Convert 25°C to Fahrenheit.
- The temperature of a room is 0°C. What is it in Fahrenheit?
- A scientist measures the temperature of a chemical reaction as 100°C. Find its equivalent in Fahrenheit.

Fahrenheit to Celsius (°F to °C):

- Convert 68°F to Celsius.
- The temperature outside is recorded as 50°F. What is it in Celsius?
- A freezer maintains a temperature of 10°F. Calculate its equivalent in Celsius.

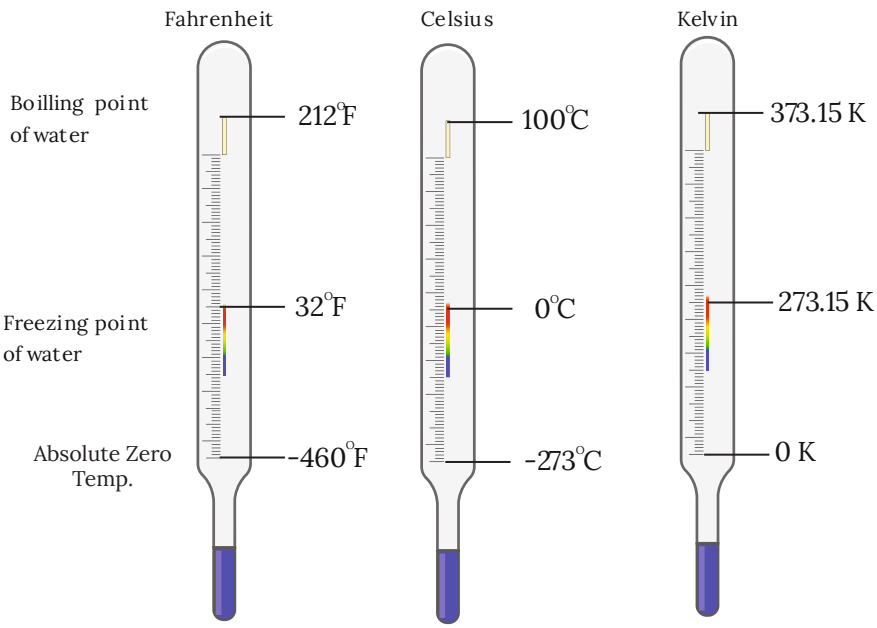


Fig. 7.1 Different Scales Temperature Conversion

Celsius to Kelvin (°C to K):

- Convert 37°C (normal human body temperature) to Kelvin.
- If the temperature of a liquid is -20°C, what is its value in Kelvin?
- The freezing point of water is 0°C. Express this temperature in Kelvin.

Kelvin to Celsius (K to °C):

- Convert 300 K to Celsius.
- A scientist cools a gas to 77 K. What is this temperature in Celsius?
- The boiling point of water is 373.15 K. Express it in Celsius.

Keywords

Absolute Zero: It is the coldest possible temperature where these tiny particles would almost completely stop wiggling. It's so cold that we can't even reach it in real life, but scientists can get very, very close!

Fact Flash

Did you know that the coldest possible temperature, where all atomic motion theoretically stops, is called Absolute Zero (−273.15 °C or−459.67 °F or 0 K)? Scientists have gotten incredibly close to this temperature in labs, but achieving it fully remains a fascinating scientific challenge!

Common Misconceptions

× **Misconception:** Temperature is the same as heat.

✓ **Correction:** Temperature is the measure of the intensity of hotness or coldness, related to particle motion. Heat is the total energy transferred between objects due to a temperature difference.

× **Misconception:** Cold is a form of energy that enters objects.

✓ **Correction:** Cold is merely the absence or lower level of heat energy. Heat flows from hotter to colder objects; "cold" does not flow.

Science Around You

Temperature is a fundamental physical quantity that describes the degree of hotness or coldness of an object. It is a measure of the average kinetic energy of the particles (atoms and molecules) within a substance. When particles move faster, the substance feels hotter, and its temperature is higher; when they move slower, it feels colder, and its temperature is lower. Temperature is crucial for countless phenomena and applications in our daily lives and across various scientific fields. From predicting weather patterns and understanding climate change to ensuring food safety during cooking and storage, a grasp of temperature is indispensable. It influences chemical reactions, the state of matter (solid, liquid, gas), and even the comfort of our homes.

Activity

Feeling Temperature Differences

- **Materials Required:** Three large bowls, Cold water (with ice cubes), Lukewarm water (room temperature), Warm water (not hot enough to scald).
- **Procedure:**
  1. **Prepare Bowls:** Fill one bowl with cold water, one with lukewarm water, and one with warm water.
  2. **Initial Immersion:** Place your right hand into the cold water and your left hand into the warm water simultaneously. Keep them immersed for about one minute.
  3. **Middle Immersion:** After one minute, quickly remove both hands and immediately place them into the lukewarm water.
  4. **Observe:** Note and describe the sensation your right hand feels and the sensation your left hand feels in the lukewarm water.

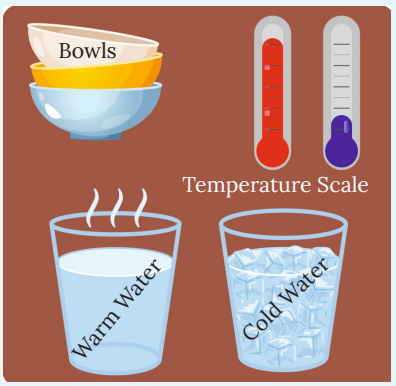


Fig. 7.2 Materials Required

- **Observation:** Observe how the lukewarm water feels different to each hand, demonstrating that our sense of touch judges temperature relatively based on prior conditions, not absolutely.

Knowledge Checkpoint

Gap Analyzer™ Homework | Watch Remedial

Remembering

Multiple Choice Questions:

1. Temperature is a measure of the average _____ of particles in a substance.
   a) Mass ☐ b) Kinetic energy ☐
   c) Volume ☐ d) Potential energy ☐
2. The freezing point of water on the Celsius scale is:
   a) 0°C ☐ b) 32°C ☐
   c) 100°C ☐ d) 273°C ☐

Understanding

3. Which temperature scale starts at absolute zero?
   a) Fahrenheit ☐ b) Celsius ☐
   c) Kelvin ☐ d) None of these ☐

Short Answer Question:

Applying

4. Describe temperature in your own words and show how it is understood in everyday life.
5. Explain why touching metal and wood in the same room feels different though both are at the same temperature.

Long Answer Question:

Evaluating

6. Explain the difference between heat and temperature. Describe how the movement of particles in a substance relates to its temperature, and provide two real-world examples where understanding this relationship is important.

Thermometer

A thermometer is a device used to measure temperature. The word "thermometer" is derived from two Latin words: "thermo," meaning heat, and "meter," meaning a measuring device. Thermometers are essential tools in various fields, as they measure temperature in units such as degrees Celsius, Fahrenheit, or Kelvin. There are two main types of thermometers commonly used: clinical thermometers and laboratory thermometers. Clinical thermometers are designed for measuring human body temperature, often used in medical settings, while laboratory thermometers are used for precise temperature measurements in scientific experiments and processes. Each type is calibrated to provide accurate readings within its intended range of use.

Clinical Thermometer

A clinical thermometer is a thermometer used to measure the body temperature of humans. It is also called a doctor's thermometer because doctors use it widely.

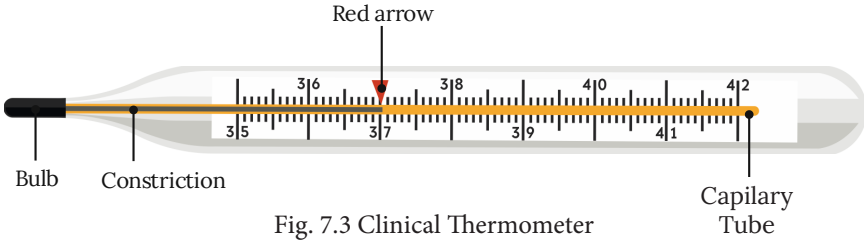


Fig. 7.3 Clinical Thermometer

Structure of a Clinical Thermometer:

- It is usually made of glass.
- It has a long, thin tube (capillary) with a bulb at one end.
- The bulb contains mercury (in older thermometers) or alcohol.
- In mercury thermometers, there is a small kink (bend) above the bulb. This prevents mercury from flowing back quickly into the bulb when the thermometer is removed. This helps keep the highest temperature reading visible.

Normal Body Temperature:

- The average healthy body temperature is 37°C (or 98.6°F).
- A clinical thermometer usually has a scale from 35°C to 42°C.
- Body temperature may change slightly due to age, activity, or time of day, but 37°C is taken as the standard normal temperature.

Digital Thermometers:

Today, digital thermometers are more common than mercury thermometers.

- They work on batteries.
- They show the temperature on a digital screen.
- They are safe, quick, and easy to use.
- They can be placed under the tongue, in the armpit, or rectally.
- When used in the armpit, the reading may be about 0.5°C to 1°C lower than the actual body temperature.

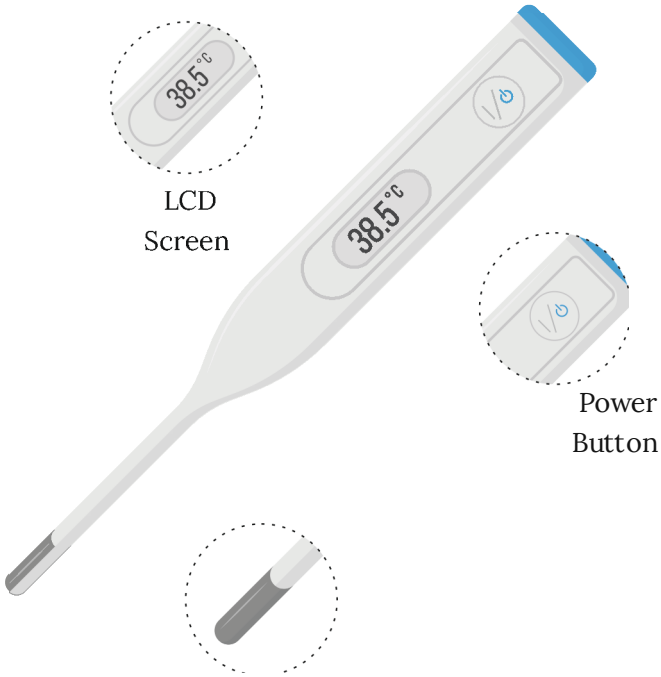


Fig. 7.4 Digital Thermometers

Laboratory Thermometer

A laboratory thermometer is used in science labs to measure the temperature of liquids and substances during experiments.

- Unlike a clinical thermometer (which measures only body temperature), a laboratory thermometer can measure a much wider range of temperatures.
- It is commonly used to check the temperature of liquids, solutions, and chemical reactions.

Range:

A laboratory thermometer usually has a temperature range from –10°C to 110°C. This allows it to measure both cold and moderately hot conditions.

Structure:

- It is a long, narrow glass tube with a bulb at one end.
- The bulb is filled with mercury or colored alcohol.
- The tube has a Celsius scale marked on it.
- The liquid inside rises when the temperature increases and falls when the temperature decreases.

Reading the Temperature:

- The temperature is read from the scale at the top of the liquid column.
- The scale is divided into equal parts.
- In most lab thermometers, each small division shows 1°C.
- Some thermometers have even smaller divisions (like 0.1°C) for very accurate readings.

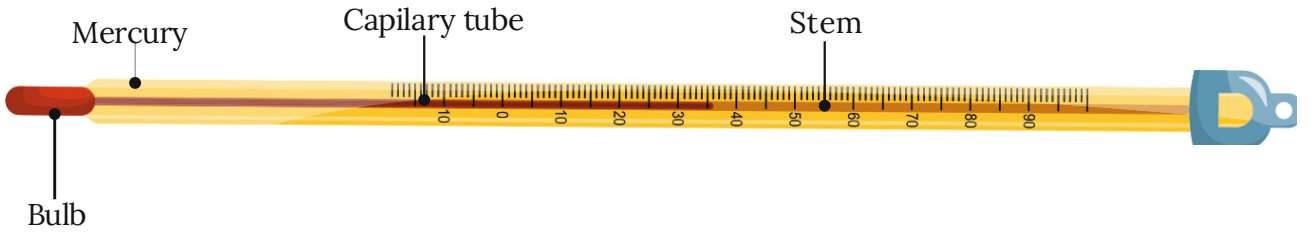


Fig. 7.5 Laboratory Thermometer

Precautions for Using a Laboratory Thermometer:

1. Handle with care – It is made of glass and can break easily.
2. Never hold it by the bulb – this may affect the reading or damage the thermometer.
3. Do not let the bulb touch other surfaces – only dip it in the solution being measured.
4. Do not shake it too hard – this may disturb the liquid inside.
5. Use the correct thermometer – different thermometers are made for different temperature ranges.
6. Keep it clean – clean after every use to avoid contamination.
7. Store safely – place it in a protective case to prevent breakage.

Air Temperature

Air temperature (also called atmospheric temperature) tells us how hot or cold the air is at a particular place and time. It is one of the most important things scientists measure in weather studies (meteorology).

You may have seen thermometers hanging on walls in schools, laboratories, hospitals, or homes. These thermometers measure the room's air temperature (how warm or cool the room is).

Air temperature changes because of many factors:

- Season (summer is hotter, winter is colder)
- Time of day (days are warmer, nights are cooler)
- Geographical location (hills are cooler, deserts are hotter)
- Weather systems (clouds, winds, storms affect temperature)

Why Air Temperature is Important

1. Weather Forecasting – Helps predict hot days, cold fronts, storms, or heatwaves.
2. Agriculture – Farmers use it to decide when to plant or harvest crops. Very hot or very cold air can damage plants.
3. Public Health
   - High temperature → heatstroke, dehydration.
   - Low temperature → frostbite, hypothermia.

   Knowing the temperature helps us stay safe.
4. Energy Use – In hot summers, we use fans/ACs. In cold winters, we use heaters. Air temperature data helps plan energy needs.

Seasonal Changes

- **Summer** – Earth tilts towards the sun → longer days, shorter nights → higher temperatures.
- **Winter** – Earth tilts away from the sun → shorter days, longer nights → lower temperatures.

These changes cause the cyclical pattern of hot and cold weather throughout the year.

Effect on Environment

- High air temperature → more evaporation → higher humidity (moisture in the air).
- Temperature differences between regions → create winds and influence storms.

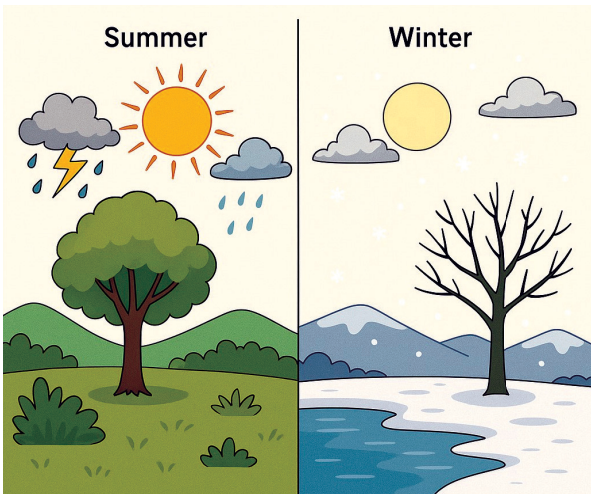


Fig. 7.6 Seasonal Variations

Fact Flash

The very first thermometer was made by Galileo Galilei in the year 1593. It was called a **thermoscope** and worked by using air to show when the temperature went up or down. However, it was not very reliable because it also changed with air pressure. A few years later, scientists like Fahrenheit and Celsius developed better versions that used liquids such as mercury and alcohol, which made them more accurate. Over time, these thermometers became very important in daily life and are now used in homes, hospitals, weather stations, and laboratories to measure temperature precisely.

Seasonal Variations in Air Temperature

As the seasons change, the temperature of the air and the length of the days change as well. During the summer months, the Earth's axis tilts toward the Sun. This tilt makes the Sun's rays fall more directly on the Earth, giving us longer days and shorter nights. With more sunlight hours, the land and air heat up quickly, leading to much higher temperatures. Summers are usually linked with hot winds, high **humidity**, heavy rainfall, and frequent thunderstorms, especially in tropical regions. People also feel the heat more because sweat evaporates slowly in the humid air, making summers feel sticky and uncomfortable.

In winter months, the Earth's axis tilts away from the Sun. The Sun's rays strike the Earth at a slant, so the heat is spread out and less intense. This creates shorter days and longer nights, resulting in much cooler temperatures. The air during winter is usually drier with lower humidity, and in colder regions, frost covers the ground and snowfall turns the land white. The difference between summer and winter reminds us how the tilt of the Earth's axis and its movement around the Sun control the climate and weather patterns we experience every year.

Common Misconceptions

× **Misconception:** You can use a clinical thermometer to measure the temperature of boiling water.

✓ **Correction:** Clinical thermometers are designed for a narrow human body temperature range and can break if exposed to much higher temperatures.

× **Misconception:** Shaking a digital thermometer resets it.

✓ **Correction:** Shaking is only for mercury thermometers to bring the liquid down. Digital thermometers reset electronically, usually by pressing a button.

Keywords

Thermoscope: A thermoscope is an early scientific instrument used to detect changes in temperature.
Humidity: Humidity is the amount of water vapor present in the air.

Science Around You

A thermometer is a device specifically designed to measure temperature accurately. The most common types of thermometers, like those containing mercury or alcohol, work on the principle of thermal expansion: as temperature increases, the liquid inside expands and rises in a narrow glass tube, indicating the temperature on a calibrated scale. There are different types of thermometers, each suited for specific purposes. Clinical thermometers are designed to measure body temperature and have a small kink that prevents the mercury level from falling quickly, allowing time for accurate reading. They typically have a narrower range (e.g., 35°C to 42°C). Laboratory thermometers, on the other hand, have a much wider range (e.g., -10°C to 110°C) and no kink, making them suitable for experiments. Modern digital thermometers use electronic sensors and are widely used for their precision and ease of reading. Understanding how to read and use thermometers correctly, and being aware of their specific ranges and precautions (especially with mercury), is essential for both scientific experiments and personal health monitoring.

Activity

Reading Different Thermometers

- **Objective:** To learn how to read and differentiate between a clinical thermometer and a laboratory thermometer.
- **Materials Required:** One clinical thermometer, One laboratory thermometer, A container of lukewarm water, A container of cold water Clinical thermometer and Laboratory thermometer side by side
- **Procedure:**
  1. **Examine Thermometers:** Carefully observe both thermometers. Note the range of temperatures marked on each. Identify the kink (if present).

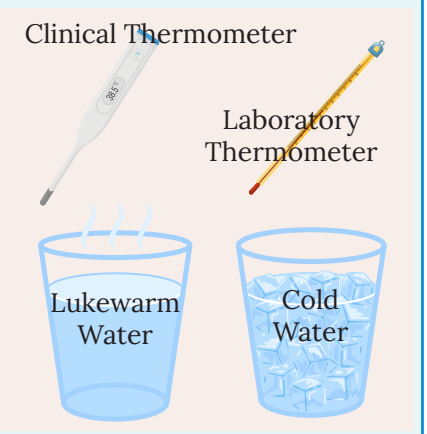


Fig. 7.7 Materials Required

  2. **Clinical Thermometer Reading:** Hold the clinical thermometer firmly and give it a few jerks to bring the mercury level below 35C. Place the bulb under your tongue for about one minute. Read and record your body temperature.
  3. **Laboratory Thermometer Reading (Warm Water):** Hold the laboratory thermometer by the stem (not the bulb). Immerse the bulb in the lukewarm water, ensuring the bulb doesn't touch the bottom or sides. Wait for the mercury/alcohol level to become steady. Read and record the temperature.
  4. **Laboratory Thermometer Reading (Cold Water):** Carefully move the laboratory thermometer to the cold water. Wait for the level to stabilize. Read and record the temperature.
  5. **Compare:** Note the differences in scale, range, and presence/absence of a kink between the two thermometers.
- **Observation:** Notice the distinct features of each thermometer, particularly their temperature ranges and mechanisms for reading, which make them suitable for different measuring tasks.

Knowledge Checkpoint

Gap Analyzer™ Homework

Watch Remedial

Remembering

Understanding

Applying

Analyzing

Multiple Choice Questions:

1. The liquid commonly used in traditional thermometers is:

   a) Water ☐ b) Alcohol ☐

   c) Mercury ☐ d) Glycerine ☐

2. **Why does a clinical thermometer have a kink near its bulb?**

   a) To make it look fancy ☐

   b) To prevent the mercury level from falling quickly ☐

   c) To allow it to measure very high temperatures ☐

   d) To make it easier to hold ☐

3. Which thermometer would you use to measure the temperature of boiling water in a lab?

   a) Clinical thermometer ☐ b) Digital thermometer (for body temp) ☐

   c) Laboratory thermometer ☐ d) Outdoor thermometer ☐

Short Answer Question:

4. List two differences between a clinical thermometer and a laboratory thermometer.
5. Explain how a liquid-in-glass thermometer works on the principle of expansion of liquids.

Long Answer Question:

6. Describe the structure and working of a typical liquid-in-glass thermometer. Explain why different types of thermometers (like clinical and laboratory) are needed for various purposes.

SUMMARY

Temperature

Temperature measures how hot or cold an object or environment is. It influences heat flow, states of matter, and energy transfer, reflecting the average kinetic energy of particles. Common units include Celsius (°C), Fahrenheit (°F), and Kelvin (K).

- Definition: Measures the average kinetic energy of particles.
- Significance: Affects heat flow, matter states, and energy transfer.
- Units: Commonly measured in °C, °F, and K.
- Temperature Scales

Thermometers

Thermometers are instruments used to measure temperature. They function by detecting the changes in physical properties, such as the expansion of liquids or gases, as temperature changes. Thermometers are commonly classified based on their application and the type of measurement they provide.

Clinical Thermometer

- A clinical thermometer is designed specifically to measure body temperature. It is used in medical settings and at home to check the health status of individuals. Traditionally, these thermometers used mercury, but digital versions have largely replaced mercury thermometers due to safety concerns.
- **Structure:** It consists of a long, narrow glass tube with a bulb at one end. The bulb contains a liquid (usually mercury or alcohol) that expands with an increase in temperature.
- **Range:** It typically measures temperatures from 35°C to 42°C (95°F to 107.6°F), the normal range for human body temperature.
- **Usage:** The thermometer is placed under the tongue, in the armpit, or rectally to obtain an accurate body temperature reading.
- **Safety Tip:** Clinical thermometers must be handled carefully, as mercury thermometers can break and release toxic mercury.

Laboratory Thermometer

A laboratory thermometer is used for measuring the temperature of liquids or substances in scientific experiments. Unlike clinical thermometers, these are designed to handle higher or lower temperature ranges and are more precise.

Measures temperatures in scientific experiments with a range of -10°C to 110°C.

Used by placing it in a substance to read the liquid column's height.

Air Temperature

Air temperature measures the temperature of the surrounding atmosphere. It is an essential parameter in weather forecasting and environmental studies, as it determines the local climate and affects numerous aspects of daily life, such as energy usage, agriculture, and health.

Indicates the surrounding atmosphere's temperature, essential for weather and climate studies.

Measured using outdoor thermometers in shaded areas to avoid sunlight interference.

Example Based Questions

Multiple Choice Questions

1. Which of the following instruments is used to measure body temperature?

(a) Laboratory thermometer
(b) Clinical thermometer
(c) Digital clock
(d) Measuring cylinder

Answer: (b) Clinical thermometer

Explanation: A clinical thermometer is specially designed for measuring human body temperature, usually ranging from 35°C to 42°C. Laboratory thermometers are used for experiments, not for measuring fever.

2. A person's body temperature is recorded as 100.4°F. What does this indicate?

(a) The person has normal temperature
(b) The person has a fever
(c) The thermometer is faulty
(d) The reading is incorrect

Answer: (b) The person has a fever

Explanation: The normal human body temperature is about 98.6°F (37°C). A reading of 100.4°F is higher than normal, which indicates fever.

Short Answer Questions

4. Why does a clinical thermometer have a kink (constriction) in its capillary tube?

Answer: The kink in a clinical thermometer prevents the mercury from falling back quickly when the thermometer is taken out of the mouth or armpit. This allows the user to read the maximum temperature reached even after removing the thermometer. Without the kink, mercury would slide back instantly, making it impossible to record the reading.

4. Why is mercury commonly used in thermometers instead of water?

Answer:

Mercury is used because:

1. It expands uniformly with heat, giving accurate readings.
2. It has a shiny appearance, making it easy to see the level in the tube.
3. It remains liquid over a wide temperature range.
4. Unlike water, it does not stick to the glass tube, so readings are clear.

This makes mercury a reliable and visible liquid for thermometers.

Long Answer Questions

7. Compare clinical thermometers and laboratory thermometers. Write at least four differences along with their uses.

Answer: Clinical and laboratory thermometers differ in several ways:

1. Range:

- Clinical thermometer: 35°C to 42°C (suitable for human body).
- Laboratory thermometer: −10°C to 110°C (suitable for experiments).

2. Design:

- Clinical thermometer: Has a kink to prevent mercury from falling back.
- Laboratory thermometer: No kink, as readings are taken while it is in contact with the object.

3. Use:

- Clinical thermometer: Used by doctors, nurses, and at home to measure fever.
- Laboratory thermometer: Used in science labs for heating and cooling experiments.

4. Handling:

- Clinical thermometer: Held under the tongue or in the armpit.
- Laboratory thermometer: Kept upright in liquids or experimental setups.

Conclusion: Both instruments are important, but their design and range are chosen according to purpose. Using the wrong thermometer would lead to incorrect readings.

Gap Analyzer™
Complete Chapter Test

EXERCISE

A. Choose the correct answer.

1. What is the SI unit of temperature?
   (a) Celsius ☐ (b) Fahrenheit ☐
   (c) Kelvin ☐ (d) Joule ☐
2. Which thermometer is used to measure the temperature of the human body?
   (a) Laboratory thermometer ☐ (b) Digital thermometer ☐
   (c) Infrared thermometer ☐ (d) Clinical thermometer ☐
3. What happens to the mercury level in a thermometer when the temperature increases?
   (a) It falls ☐ (b) It rises ☐
   (c) It remains the same ☐ (d) It disappears ☐
4. Which of the following is a normal body temperature in Celsius?
   (a) 25°C ☐ (b) 37°C ☐
   (c) 50°C ☐ (d) 100°C ☐
5. What is the freezing point of water on the Fahrenheit scale?
   (a) 0°F ☐ (b) 32°F ☐
   (c) 100°F ☐ (d) 212°F ☐

B. Fill in the blanks.

1. The normal human body temperature is ____ degrees Celsius.
2. A thermometer uses ____ to measure temperature changes.
3. The ____ thermometer can measure both hot and cold temperatures accurately.
4. The boiling point of water is ____ degrees Celsius.
5. Temperature is a measure of the ____ energy of particles in a substance.

C. Write True or False.

1. Mercury is commonly used in traditional thermometers because it expands uniformly with temperature. ____
2. The Celsius and Kelvin scales are the same, except for the starting point. ____
3. A clinical thermometer can measure very high temperatures. ____
4. Body temperature is always measured in Kelvin. ____
5. Air temperature in extreme cold cannot be measured as thermometers freeze. ____

D. Define the following terms.

1. Temperature
2. Thermometer
3. Boiling Point
4. Freezing Point
5. Clinical Thermometer

E. Match the columns.

	Column A		Column B
1.	Clinical thermometer	(a)	100°C
2.	Mercury	(b)	Uniform expansion with heat
3.	Laboratory thermometer	(c)	Measures water boiling temperature
4.	Kelvin scale	(d)	Starts at absolute zero
5.	Boiling point of water	(e)	Used for body temperature

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:** You should not use a clinical thermometer to measure the temperature of boiling water.

   Reason: Clinical thermometers have a limited range and can break at very high temperatures.

2. **Assertion:** Our sense of touch is a reliable way to measure the exact temperature of an object.

   Reason: Our sense of touch is relative and influenced by previous sensations.

3. **Assertion:** Laboratory thermometers usually have a wider temperature range than clinical thermometers.

   Reason: They are used for a variety of experiments that may involve very hot or very cold substances.

G. Give reasons for the following statements.

1. Mercury is preferred in thermometers for measuring temperature.
2. A clinical thermometer cannot be used to measure boiling water.
3. Air temperature in cold regions can be challenging to measure due to extreme conditions.
4. The Kelvin scale is used in scientific measurements.

H. Answer in brief.

1. What is the difference between the Celsius and Fahrenheit scales?
2. Why are laboratory thermometers unsuitable for measuring body temperature?
3. How does a clinical thermometer work?
4. Explain why mercury is a good choice for use in thermometers.

I. Answer in detail.

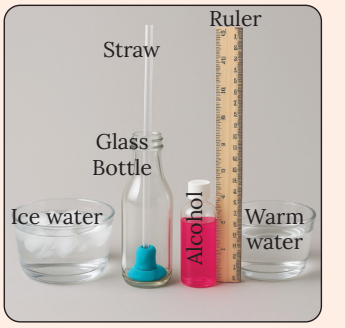
1. Explain the importance of measuring temperature accurately in daily life.
2. Compare and contrast the Celsius, Fahrenheit, and Kelvin scales.
3. Describe the construction and working of a clinical thermometer.
4. How does a laboratory thermometer differ from a clinical thermometer?

SKILL-BASED PRACTICE

Activity Time

STEM

Calibrating a Simple Thermometer



Materials Required

Materials Needed: A clear glass bottle with narrow neck (or plastic bottle with hole in cap for straw), clear drinking straw, Play-Doh or modeling clay, rubbing alcohol (coloured with food colouring), ruler or meter stick, two containers: one with ice water, one with warm water.

Activity Steps:

1. **Prepare Thermometer:** Fill the bottle with colored alcohol. Insert the straw into the bottle, ensuring it doesn't touch the bottom. Seal the neck around the straw with Play-Doh so no air can escape.
2. **Establish Reference Points:** Place the bottle in ice water and mark the alcohol level as "Cold" (0°C). Then place it in warm water and mark the new level as "Warm."
3. **Test:** Move your homemade thermometer to different places (e.g., in front of a fan, near a window) and observe how the liquid level changes.
4. **Compare:** If possible, compare its readings with a real thermometer.

Questions:

- What happens to the alcohol level when the bottle is placed in warmer conditions?
- What principle of temperature measurement does this activity demonstrate?
- How could you make your homemade thermometer more accurate?

Skills Covered: Model Building, Observation, Understanding Thermal Expansion, Basic Experimentation, Scientific Principles

Creativity

Art

"Temperature Art" Graph Create an artistic bar graph or line graph showing the average monthly temperatures for your city over a year, using different colours or textures to represent changes in hotness and coldness. Add small drawings or symbols to denote weather (e.g., sun for hot, snowflake for cold, rain cloud).

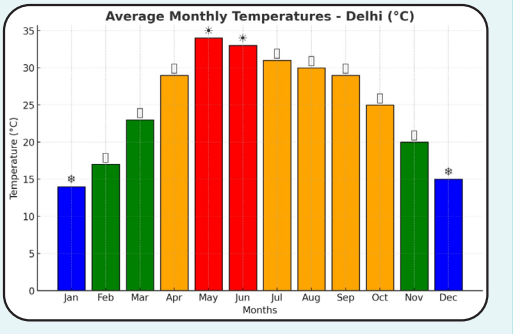


Chart paper or drawing board, Coloured pencils, markers, or paints, Ruler, Online source for average monthly temperatures (e.g., local weather site)

Questions:

1. Which month was the hottest according to your data? Which was the coldest?
2. How did you use colours or textures to visually represent the change in temperature?
3. What does your graph tell you about the temperature patterns in your city throughout the year?

Skills Covered: Data Visualization, Graphing Skills, Understanding Temperature Trends

Thermometer Design Inquiry

Group Activity

Designing a Thermometer for a Specific Use

1. **Choose a Use:** As a group, choose one specific scenario where temperature needs to be measured (**e.g.**, a baby's bath water, an outdoor garden, a refrigerator, a cooking oven).
2. **Brainstorm Requirements:** List the key characteristics the thermometer would need for this specific use (**e.g.,** range, accuracy, safety, ease of reading, durability).
3. **Design Sketch:** Sketch a design for your thermometer, labeling its parts and indicating how it would measure temperature. Consider what liquid (or other mechanism) it might use.
4. **Present Design:** Present your design to the class, explaining your material choices and design features based on the requirements.

Questions:

- What temperature range would your thermometer need to cover?
- What material would you use for the thermometer's bulb or sensor? Why?
- How would you make sure your thermometer is safe and easy to use for its intended purpose?
- What challenges might you face in manufacturing this type of thermometer?

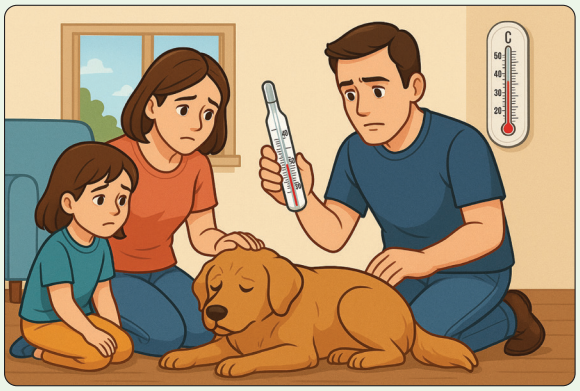
Skills Covered: Design Thinking, Application of Concepts, Collaboration, Presentation Skills

The Sick Pet Mystery

Case Study

Read the given passage below and answer the question:

A family notices their pet dog, Buddy, is not eating and seems lethargic. They suspect he might have a fever. They have a regular clinical thermometer they use for themselves, and a large outdoor thermometer that hangs on the wall.



The Sick Pet

Guiding Questions:

1. Which type of thermometer should they use to check Buddy's temperature: the clinical thermometer or the outdoor thermometer?
2. Why is it important to use a thermometer specifically designed for body temperature in this situation?
3. If Buddy's normal temperature is about 38.5°C, and the thermometer reads 40°C, what does that indicate?
4. Would it be accurate to check Buddy's temperature by just feeling his nose or ears? Why or why not?
5. What might happen if they tried to measure Buddy's temperature with the outdoor thermometer?

Skills Covered: Classification, Analysis, Teamwork, Communication, Scientific Investigation

Temperature & Thermometer

Source Based Question

"The thermometer has a long history going back to the 17th century. Galileo created an early device called the thermoscope, which could show changes in hotness or coldness but had no proper scale. Later, Santorio Santorio added a scale to improve accuracy. In the 18th century, Daniel Fahrenheit developed the mercury-in-glass thermometer and introduced a standard scale. This invention made temperature measurement more reliable and useful for science, medicine, and daily life."

Questions:

1. Who first created the device to measure hotness or coldness, and what was it called?
2. What improvement did Santorio Santorio make to the thermoscope?
3. Why was the mercury-in-glass thermometer by Fahrenheit considered an important development?
4. How did these inventions change the way people measured and understood temperature?

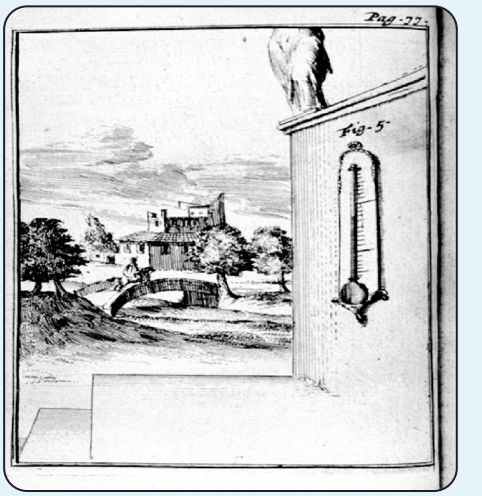


Image Credit : 'Traittez de barometres, thermometres, et notiometres, ou hygrometres' by Joachim d'Alence, Published in 1688. Photo12/Universal Images Group/ Getty Images

Skills Covered: Observation, Curiosity, Critical thinking, Connecting real-life observations