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# TEMPERATURE AND HEAT:

A Discovery Guide  
For Lower Secondary Science

TEMPERATURE AND HEAT:  
A DISCOVERY GUIDE FOR LOWER SECONDARY SCIENCE

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**Tahta Media Group**

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**TEMPERATURE AND HEAT:  
A DISCOVERY GUIDE FOR LOWER SECONDARY SCIENCE**

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Cover Design:  
Tahta Media

Editor:  
Tahta Media

Proofreader:  
Tahta Media

Size:  
xi, 75, Uk: 15,5 x 23 cm

ISBN: 978-634-262-279-7

First Print:  
August 2026

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Fill out the responsibility of printing

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IKAPI Member (216/JTE/2021)

## PREFACE

Understanding temperature and heat is essential in learning science, as these concepts are closely related to everyday life. However, students often find them difficult to distinguish and fully understand. This book, *Temperature and Heat: A Discovery Guide for Lower Secondary Science*, is designed to help students develop a clear understanding through guided discovery and simple, engaging activities.

This textbook presents key topics such as temperature, measurement, the difference between heat and temperature, and heat transfer in a structured and accessible way. It encourages students to think critically and connect scientific concepts with real-life situations.

The authors hope that this book will be a useful resource for both students and teachers in supporting effective science learning.

Bandung, 04 Agustus 2026

The Author

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# CHAPTER 1

## WHAT IS TEMPERATURE?

### INTRODUCTION

Every day, we experience temperature in many ways. We feel the warmth of sunlight on our skin, the coolness of a drink, or the heat from a stove. These experiences help us describe objects as “hot” or “cold.” However, in science, temperature is more than just a feeling—it is a measurable physical quantity that helps us understand the behavior of matter.

Although our senses can detect temperature differences, they are not always reliable. For example, an object may feel colder or warmer depending on the condition of our skin. Therefore, scientists use a more precise definition of temperature based on the motion of particles.

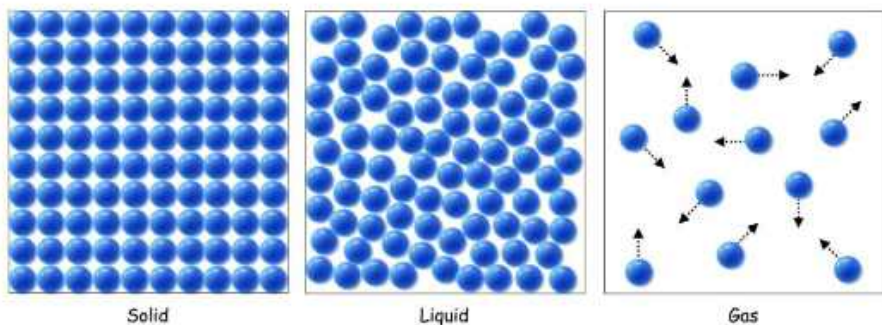
### LEARNING OBJECTIVES

At the end of this chapter, students should be able to:

1. Define temperature as a physical quantity
2. Explain temperature using the particle model of matter
3. Describe the relationship between temperature and kinetic energy
4. Identify **Common Misconceptions** about temperature
5. Relate temperature to everyday experiences

## A. THE PARTICLE NATURE OF MATTER

All matter is made up of tiny particles such as atoms and molecules. These particles are in constant motion, even in solids where they appear to be fixed in place.]



[www.sciencelearn.org.nz](http://www.sciencelearn.org.nz) | © The University of Waikato Te Whare Wānanga o Waikato

**Figure 1. 1 Stay Warm With thermal**

Source : Canva.com

All matter is made up of tiny particles such as atoms and molecules. These particles are in constant motion, even in solids where they appear to be fixed in place.

## B. TEMPERATURE AND PARTICLE MOTION

Temperature is defined as a measure of the **average kinetic energy** of the particles in a substance. Kinetic energy is the energy of motion, meaning that the faster the particles move, the higher their kinetic energy.

When an object is heated:

- The particles gain energy
- Their motion becomes faster
- The temperature increases

When an object is cooled:

- The particles lose energy

- Their motion slows down
- The temperature decreases

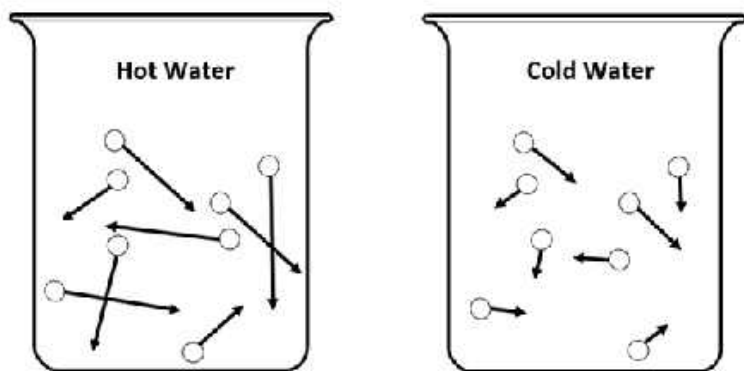


**Figure 1.2 Modeling Temperature**

Source : Canva.com

For example, when water is heated, its molecules move faster and may eventually escape into the air as steam. When water is cooled, the molecules slow down and may form ice.

### **C. A SIMPLE ANALOGY: THE DANCE FLOOR**

To better understand temperature, imagine a dance floor.

- When slow music is playing, dancers move slowly and stay close together.
- When fast music is playing, dancers move quickly and energetically.

In this analogy:

- Dancers represent particles
- Their movement represents kinetic energy
- The speed of the dance represents temperature

Thus, temperature reflects how “active” the particles are.

#### D. HEAT FLOW AND SENSATION OF COLD

When you touch an ice cube, your hand feels cold. However, scientifically, this happens because heat energy flows from your hand (which is warmer) to the ice (which is colder).

This means:

- Heat flows from higher temperature to lower temperature
- “Coldness” does not move heat moves instead

This concept is important because it corrects a common misconception.

#### E. ABSOLUTE ZERO

There is a theoretical lowest temperature known as **absolute zero**, which is 0 Kelvin ( $-273.15^{\circ}\text{C}$ ). At this temperature, particle motion is minimized.

Although it is impossible to reach absolute zero exactly, scientists can get very close to it in laboratory conditions.

#### F. COMMON MISCONCEPTIONS

Many students have misunderstandings about temperature, such as:

- ❌ “Cold is something that flows.”  
✅ In reality, heat flows from hot to cold.
- ❌ “Bigger objects always have higher temperature.”  
✅ Temperature depends on particle motion, not size.
- ❌ “Metal is naturally colder than wood.”  
✅ Metal only feels colder because it conducts heat faster.

## **G. TEMPERATURE IN EVERYDAY LIFE**

Understanding temperature helps explain many everyday phenomena:

- Why ice melts
- Why hot drinks cool down
- Why weather changes
- Why refrigerators work

Temperature is essential in science, technology, and daily life.

### **THINK-PAIR-SHARE**

Discuss with a partner:

1. Why does metal feel colder than wood at the same temperature?
2. What happens to particle motion when an object is heated?

### **MINI INVESTIGATION**

#### **Activity: Comparing Sensations**

Materials:

- Bowl of cold water
- Bowl of warm water
- Bowl of room-temperature water

Steps:

1. Place one hand in cold water and the other in warm water.
2. After 30 seconds, place both hands in room-temperature water.

Observation:

Each hand feels a different temperature.

Conclusion:

Human senses are not reliable for measuring temperature.

## PRACTICE QUESTIONS

### Multiple Choice

1. Temperature is a measure of:
  - A. Mass
  - B. Particle motion
  - C. Volume
2. When temperature increases, particle motion:
  - A. Decreases
  - B. Stays the same
  - C. Increases

### SHORT ANSWER

1. Explain temperature using particle motion.
2. Why does an ice cube feel cold when touched?

## CHAPTER SUMMARY

Temperature is a physical quantity that measures the average kinetic energy of particles in a substance. All matter is made up of particles that are constantly in motion, and the speed of this motion determines how hot or cold an object is. Understanding temperature helps explain many natural phenomena and corrects **Common Misconceptions** about heat and cold.

# **CHAPTER 2**

## **MEASURING TEMPERATURE**

### **INTRODUCTION**

In the previous chapter, we learned that temperature is related to the motion of particles. However, relying on our senses alone is not enough to measure temperature accurately. For example, water may feel warm or cold depending on the condition of our hands.

To overcome this limitation, scientists developed instruments that can measure temperature precisely. These instruments are called **thermometers**. Understanding how thermometers work and how temperature is measured is essential in both science and everyday life.

### **LEARNING OBJECTIVES**

At the end of this chapter, students should be able to:

- Explain why temperature needs to be measured objectively
- Identify the parts and function of a thermometer
- Describe how thermometers work based on thermal expansion
- Use and read the Celsius scale correctly
- Recognize different temperature scales (Celsius, Kelvin, Fahrenheit)

### A. WHY DO WE NEED TO MEASURE TEMPERATURE?

Human senses can detect differences in temperature, but they are not reliable measuring tools. This is because our perception depends on prior conditions.

For instance, if one hand is placed in cold water and the other in warm water, and then both are placed in room-temperature water, each hand will feel a different sensation. This shows that our sense of touch cannot provide accurate temperature measurements.

Therefore, scientists use standardized instruments to measure temperature objectively and consistently.

### B. WHAT IS A THERMOMETER?

A **thermometer** is an instrument used to measure temperature. Most traditional thermometers consist of:

- A glass tube
- A liquid (such as alcohol or mercury)
- A scale marked along the tube

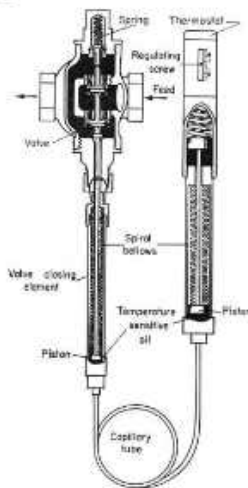


Figure 2. 1 Liquid Expansion

Source : Canva.com

The liquid inside the thermometer responds to temperature changes by expanding or contracting. This change is visible and can be read on the scale.

### C. HOW DOES A THERMOMETER WORK?

Thermometers work based on the principle of **thermal expansion**.

When a substance is heated:

- Its particles move faster
- The distance between particles increases
- The substance expands

When a substance is cooled:

- Particles move slower
- The substance contracts

In a thermometer:

- The liquid expands when heated and rises in the tube
- The liquid contracts when cooled and falls

This movement allows us to determine the temperature by reading the scale.

### D. THE CELSIUS SCALE

One of the most commonly used temperature scales is the **Celsius scale** (°C). It is based on two fixed reference points using water:

- 0°C → Freezing point of water
- 100°C → Boiling point of water

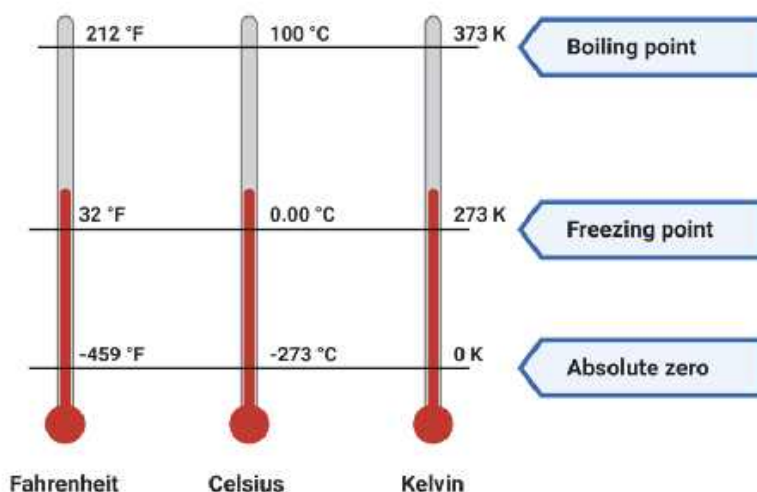


**Figure 2. 2 Temperature Scales**

Source : Canva.com

The interval between these two points is divided into 100 equal parts, called degrees.

## E. OTHER TEMPERATURE SCALES

In addition to Celsius, there are two other commonly used temperature scales:

### Kelvin Scale (K)

- Used in scientific research
- Starts at absolute zero (0 K)
- No negative values

Relationship:

$$K = ^\circ C + 273$$

### Fahrenheit Scale (°F)

- Commonly used in the United States
- Freezing point: 32°F

- Boiling point: 212°F

These different scales allow temperature to be measured in various contexts.

## F. TYPES OF THERMOMETERS

Modern technology has introduced different types of thermometers, such as:

- **Liquid thermometers** (alcohol or mercury)
- **Digital thermometers**
- **Infrared thermometers**
- **Clinical thermometers** (for body temperature)

Each type is designed for specific purposes, such as medical use, laboratory experiments, or weather measurement.

## G. COMMON MISCONCEPTIONS

Some common misunderstandings about temperature measurement include:

-  "Thermometers measure heat."  
 Thermometers measure temperature, not heat.
-  "All thermometers work the same way."  
 Different thermometers use different principles.
-  "Our skin can measure temperature accurately."  
 Our senses can be misleading.

## H. TEMPERATURE MEASUREMENT IN EVERYDAY LIFE

Temperature measurement plays an important role in many areas, such as:

- Monitoring body temperature during illness

- Cooking food at the correct temperature
- Predicting weather conditions
- Conducting scientific experiments

Accurate measurement helps ensure safety, quality, and understanding.

### **THINK-PAIR-SHARE**

Discuss the following questions:

1. Why can't human skin be used as an accurate thermometer?
2. Why is the Celsius scale based on water?

### **MINI INVESTIGATION**

#### **Activity: Human Thermometer Experiment**

Materials:

- Bowl of cold water
- Bowl of warm water
- Bowl of room-temperature water

Procedure:

1. Place one hand in cold water and the other in warm water for 30 seconds.
2. Then place both hands in room-temperature water.

Observation:

Each hand feels a different temperature.

Conclusion:

Temperature perception is relative, not absolute.

## **PRACTICE QUESTIONS**

### **Multiple Choice**

1. Thermometer measures:
  - A. Heat
  - B. Temperature
  - C. Energy
2. The liquid in a thermometer rises because:
  - A. It becomes heavier
  - B. It expands when heated
  - C. It changes color

### **SHORT ANSWER**

1. Explain how a thermometer works.
2. What are the fixed points of the Celsius scale?

## **CHAPTER SUMMARY**

Temperature must be measured using reliable instruments because human senses are not accurate. Thermometers work based on the expansion and contraction of substances due to temperature changes. The Celsius scale is widely used and is based on the freezing and boiling points of water. Understanding how temperature is measured is essential for both scientific study and everyday applications.

# **CHAPTER 3**

## **HEAT VS TEMPERATURE**

### **INTRODUCTION**

In everyday language, people often use the terms heat and temperature interchangeably. For example, we might say, “This object has a lot of heat” or “The heat today is very high.” However, in science, these terms have distinct meanings.

Understanding the difference between heat and temperature is essential because it helps explain how energy moves and how materials respond to heating and cooling. This chapter will clarify these concepts using the particle model of matter and real-life examples.

### **LEARNING OBJECTIVES**

At the end of this chapter, students should be able to:

- Define heat as a form of energy transfer
- Distinguish clearly between heat and temperature
- Explain heat transfer using the particle model
- Apply the concepts to real-life situations
- Identify and correct **Common Misconceptions**

### A. WHAT IS TEMPERATURE?

Temperature is a measure of the **average kinetic energy** of particles in a substance. It tells us how fast the particles are moving on average.

- Higher temperature → faster particle motion
- Lower temperature → slower particle motion

Temperature does not depend on how much substance is present.

### B. WHAT IS HEAT?

Heat is a form of energy transfer that occurs due to a temperature difference between two objects.

When two objects with different temperatures come into contact:

- Heat flows from the hotter object to the colder object
- The flow continues until both objects reach thermal equilibrium

This means:

- Heat is not stored as a property like mass or volume
- Heat exists only when energy is being transferred

### C. THE KEY DIFFERENCE BETWEEN HEAT AND TEMPERATURE

The distinction between heat and temperature can be summarized as follows:

| Concept            | Temperature                | Heat            |
|--------------------|----------------------------|-----------------|
| Definition         | Measure of particle motion | Energy transfer |
| Depends on amount? | No                         | Yes             |
| Unit               | °C, K, °F                  | Joules (J)      |
| Nature             | State property             | Process         |

## GLOSSARY

### A

#### **Absolute Zero**

The lowest possible temperature at which particles have minimal motion (0 Kelvin or  $-273^{\circ}\text{C}$ ).

### B

#### **Bimetallic Strip**

A device made of two different metals that expand at different rates, causing it to bend when heated.

### C

#### **Celsius ( $^{\circ}\text{C}$ )**

A unit used to measure temperature based on the freezing ( $0^{\circ}\text{C}$ ) and boiling ( $100^{\circ}\text{C}$ ) points of water.

#### **Conduction**

The transfer of heat through direct contact between particles, usually in solids.

#### **Conductor**

A material that allows heat to pass through it easily, such as metals.

#### **Contraction**

The decrease in size of a material when it is cooled.

#### **Convection**

The transfer of heat through the movement of liquids or gases.

#### **Convection Current**

A circular movement of fluid caused by rising warm fluid and sinking cool fluid.

### D

#### **Density**

The amount of mass in a given volume of a substance.

## **E**

### **Energy**

The ability to do work or cause change.

### **Expansion**

The increase in size of a material when it is heated.

### **Expansion Joint**

A gap left in structures like bridges or railway tracks to allow expansion.

## **F**

### **Fluid**

A substance that can flow, such as liquids and gases.

## **H**

### **Heat**

A form of energy that is transferred from a hotter object to a colder one.

## **I**

### **Insulator**

A material that does not allow heat to pass through easily.

### **Infrared Radiation**

A type of electromagnetic wave that transfers heat energy.

## **K**

### **Kinetic Energy**

The energy of motion possessed by particles.

## **M**

### **Mass**

The amount of matter in an object.

## **P**

### **Particle Model**

A scientific model that explains matter as being made of tiny moving particles.

## **R**

### **Radiation**

The transfer of heat through electromagnetic waves without needing a medium.

## **S**

### **Specific Heat Capacity**

The amount of heat energy required to raise the temperature of a substance by 1°C.

## **T**

### **Temperature**

A measure of how hot or cold an object is, related to the motion of its particles.

### **Thermal Energy**

The total energy of all the particles in a substance.

### **Thermal Expansion**

The increase in size of a material when heated.

### **Thermal Equilibrium**

A condition where two objects reach the same temperature and no heat flows between them.

### **Thermometer**

An instrument used to measure temperature.

## **V**

### **Vacuum**

A space with no particles, where conduction and convection cannot occur.

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