

Unit 7

Temperature and Thermometry

Introduction to Temperature and Thermometry

Understanding Temperature

Temperature is a way to describe how hot or cold something is. For example, the water in your shower might feel hot, warm, or cold. We use temperature to measure these differences in heat. In this unit, you'll learn about:

- What temperature is and how it affects us.
- Different temperature measuring scales.
- How to use various thermometers.
- How to convert temperatures between different scales.
- The concept of linear expansion of solids.

Temperature and Our Life

Temperature is a measure of the average kinetic energy of the particles in a substance. It's not always reliable to judge temperature by touch alone, as our perception can be affected by previous experiences (e.g., water that feels warm after hot water might feel cool).

Effects of Temperature on Life

- **Human Comfort:** We are comfortable in temperatures between 18°C and 22°C (room temperature). Extreme temperatures can affect clothing, health, and even the economy.
- **Geographical Variation:** Temperature varies across Earth. Polar regions are cold, temperate regions have moderate temperatures, and tropical regions are hot. This variation is due to the amount of solar energy received at different latitudes.

Extreme Temperature Safety

Maintaining Healthy Temperature

Our body temperature is normally between 36.5°C and 37.2°C. To stay comfortable, the surrounding temperature needs to be around 28°C. Extreme temperatures can be dangerous:

- **High Temperatures:** Between 32°C and 40°C, you may experience heat cramps or exhaustion. Above 40°C, heat stroke can occur.
- **Low Temperatures:** Prolonged exposure to very cold temperatures can lead to hypothermia and frostbite.

Temperature Change and Its Effects

Global Warming

Global warming refers to the increase in Earth's average temperature due to human activities, particularly the emission of greenhouse gases like carbon dioxide and methane.

- **Current Trends:** The global average temperature has increased by about 0.8°C over the past century. 2016 was one of the hottest years on record.
- **Impacts:** Higher temperatures lead to more frequent and severe heatwaves, affecting health, weather patterns, and ecosystems.

Greenhouse Effect

- **Natural vs. Enhanced:** The natural greenhouse effect keeps Earth warm enough for life. However, human activities are intensifying this effect, leading to global warming.

Measuring Temperature with Different Thermometric Scales

Thermometers

A thermometer measures temperature by observing the expansion or contraction of a substance (e.g., mercury or alcohol) inside a tube.

Temperature Scales

1. **Celsius Scale (°C):** Developed by Anders Celsius, where 0°C is the freezing point of water and 100°C is the boiling point.
2. **Fahrenheit Scale (°F):** Developed by Daniel Fahrenheit, where 32°F is the freezing point of water and 212°F is the boiling point.
3. **Kelvin Scale (K):** Developed by Lord Kelvin, used in scientific contexts. 0 K is absolute zero (-273.15°C), the lowest possible temperature.

Reading Thermometers

- **Mercury Thermometers:** Mercury expands with heat and contracts with cold. The level of mercury indicates the temperature.

- **Alcohol Thermometers:** Similar to mercury thermometers but use alcohol, which is often colored for better visibility.

Types of Thermometers and Their Uses

Thermometers are instruments used to measure temperature by detecting changes in physical properties. Different types of thermometers use various thermometric properties. Here's a brief overview of some common types:

1. Mercury Thermometer

- **How It Works:** Contains mercury in a glass tube. Mercury expands and contracts with temperature changes, moving along a calibrated scale.
- **Temperature Range:** -30°C to 300°C .
- **Uses:** Measuring body temperature, liquid temperatures, and in laboratories and industrial applications.

2. Alcohol Thermometer

- **How It Works:** Uses alcohol, often ethanol, which expands and contracts with temperature changes. The alcohol is colored for visibility.
- **Temperature Range:** -115°C to 78.15°C .
- **Uses:** Safe for use in environments where mercury is not desired, such as for very low temperatures.

3. Resistance Thermometer

- **How It Works:** Measures temperature by detecting changes in electrical resistance of a material, typically platinum.
- **Temperature Range:** -270°C to 700°C .
- **Uses:** High-precision measurements in industrial and scientific applications.

4. Thermocouple

- **How It Works:** Consists of two different metals joined at one end. The temperature difference between the joined end and the other end generates a voltage, which is measured to determine temperature.
- **Temperature Range:** -270°C to 2300°C .
- **Uses:** Extensive use in laboratories and industries for measuring high and low temperatures.

5. Thermistor

- **How It Works:** A type of resistor whose resistance changes with temperature. There are two types: Negative Temperature Coefficient (NTC) and Positive Temperature Coefficient (PTC).

- **Temperature Range:** About 50°C around the target temperature.
- **Uses:** High-precision temperature measurements in electronics and various devices.

6. Radiation Thermometer

- **How It Works:** Measures temperature by detecting the electromagnetic radiation emitted by an object. The more radiation emitted, the higher the temperature.
- **Temperature Range:** Broad range depending on the application.
- **Uses:** Common in industrial processes and situations where contact measurements are impractical.