Hot and Cold

Understanding Temperature in Daily Life

In our daily life, we encounter objects that feel hot or cold. For example, ice cream is cold, while tea is hot. The sensation of hotness or coldness is related to the temperature of the object. Temperature is a measure of how hot or cold something is, and it is measured in degrees Celsius (°C) or Fahrenheit (°F).

Limitations of Sense of Touch

We often use our sense of touch to judge if something is hot or cold. However, this method is not always reliable. For instance, if you dip one hand in hot water and the other in cold water, then place both hands in lukewarm water, each hand may feel the water differently. This shows that our perception of temperature can be influenced by prior exposure and is subjective.

Temperature and Thermometers

To measure temperature accurately, we use devices called thermometers. Temperature is a quantitative measure of hotness or coldness, unlike the qualitative sense of touch.

Solving Examples

Example 1: You have two cups of water, one at 40°C and the other at 20°C. Which cup feels hotter to touch?

Solution: The cup at 40°C feels hotter because it has a higher temperature. Temperature is an objective measure, so the cup with the higher temperature is hotter.

Practice Set

- **Level 1:** Name two objects that feel cold and two that feel hot in your daily life.
- **Level 2:** Explain why your left and right hands may feel different temperatures when placed in the same lukewarm water after exposure to hot and cold water.
- **Level 3:** Design an experiment to demonstrate that sense of touch is not a reliable measure of temperature.

Answer Key

- **Level 1:** Cold objects: ice cream, refrigerator; Hot objects: tea, stove.
- **Level 2:** Because the hands were conditioned to different temperatures, their sensory receptors respond differently, causing different perceptions of the same lukewarm water.
- **Level 3:** Dip one hand in hot water and the other in cold water for a few minutes, then place both hands in lukewarm water and observe the different sensations.

Measuring Temperature

Clinical Thermometer

A clinical thermometer is used to measure human body temperature. It typically measures temperatures from 35°C to 42°C. It consists of a narrow glass tube with mercury or colored alcohol inside. The liquid expands when heated and rises along the scale to indicate temperature.

Reading a Clinical Thermometer

To read a clinical thermometer, place the bulb under the tongue or in the armpit. After a minute, remove it and read the mercury level at eye level to avoid parallax error. The normal human body temperature is approximately 37°C.

Precautions

- Clean the thermometer before and after use.
- Ensure mercury level is below 35°C before use.
- Handle carefully to avoid breakage.
- Do not hold the bulb while reading.

Solving Examples

Example 2: If the mercury level in a clinical thermometer is at 38.5°C, what does it indicate?

Solution: It indicates a fever, as the normal body temperature is 37°C.

Practice Set

- **Level 1:** What is the normal range of a clinical thermometer?
- **Level 2:** Why should the mercury level be below 35°C before use?

- **Level 3:** Explain why a clinical thermometer has a kink in its tube.

Answer Key

- **Level 1:** 35°C to 42°C.
- **Level 2:** To ensure accurate measurement starting from below normal body temperature.
- **Level 3:** The kink prevents mercury from falling back immediately, allowing the reading to be taken after removal.

Laboratory Thermometer

Purpose and Range

A laboratory thermometer measures temperature of various substances, with a range typically from –10°C to 110°C. It is used for scientific experiments and general temperature measurements.

Usage

To measure temperature, immerse the bulb in the substance without touching the container's sides or bottom. Hold the thermometer vertically and wait for the mercury level to stabilize before reading.

Differences from Clinical Thermometer

Unlike clinical thermometers, laboratory thermometers do not have a kink, so mercury level falls back immediately when removed. They are not suitable for measuring body temperature.

Solving Examples

Example 3: A laboratory thermometer shows a mercury level at 25°C when immersed in water. What is the temperature of the water?

Solution: The water temperature is 25°C.

Practice Set

- **Level 1:** What is the typical temperature range of a laboratory thermometer?
- **Level 2:** Why should the bulb not touch the container's sides or bottom?
- **Level 3:** Explain why a laboratory thermometer is not suitable for measuring body temperature.

Answer Key

- **Level 1:** –10°C to 110°C.
- **Level 2:** To avoid inaccurate readings due to heat conduction from the container.
- **Level 3:** Because mercury level falls immediately when removed, making it difficult to read body temperature accurately.

Heat Transfer

Heat Flow Direction

Heat always flows from a hotter object to a colder object. For example, a frying pan heats up on a flame and cools down when removed because heat transfers to the surroundings.

Conduction

Conduction is the transfer of heat through a solid by direct contact of particles. Metals are good conductors because their free electrons transfer heat efficiently.

Convection

Convection is heat transfer through fluids (liquids and gases) by the movement of warmer and cooler regions. Hot fluid rises and cooler fluid sinks, creating convection currents.

Radiation

Radiation is the transfer of heat through electromagnetic waves and does not require a medium. Heat from the sun reaches the earth by radiation.

Solving Examples

Example 4: Why does the handle of a metal pan often have a wooden or plastic cover?

Solution: Wood and plastic are poor conductors (insulators) of heat, so they prevent heat transfer to the handle, making it safe to hold.

Practice Set

- **Level 1:** Name the three modes of heat transfer.
- **Level 2:** Explain why metals are good conductors of heat.
- **Level 3:** Describe how convection currents form in water when heated.

Answer Key

- **Level 1:** Conduction, convection, radiation.
- **Level 2:** Metals have free electrons that transfer heat energy quickly.
- **Level 3:** Water near the heat source becomes less dense and rises, while cooler water sinks, creating a circular flow called convection currents.

Clothes and Heat

Effect of Color on Heat Absorption

Dark-colored clothes absorb more heat, making them warmer, while light-colored clothes reflect heat, keeping us cooler. This is why dark clothes are preferred in winter and light clothes in summer.

Insulating Properties of Wool

Woollen clothes keep us warm because wool is a poor conductor of heat and traps air between fibers, reducing heat loss from the body.

Practical Applications

Buildings use materials with trapped air layers, like hollow bricks, to insulate against heat and cold.

Solving Examples

Example 5: Why do we feel warmer wearing woollen clothes in winter?

Solution: Wool traps air, which is a poor conductor, reducing heat loss from the body and keeping us warm.

Practice Set

- **Level 1:** Why do light-colored clothes feel cooler in summer?
- **Level 2:** Explain why wool is a good material for winter clothes.
- **Level 3:** Suggest a building material feature that helps in temperature regulation.

Answer Key

- **Level 1:** Light colors reflect most of the heat, keeping the body cooler.
- **Level 2:** Wool is a poor conductor and traps air, reducing heat loss.
- **Level 3:** Use of hollow bricks that trap air layers for insulation.

Quick Reference Table

- **Temperature:** Measure of hotness or coldness, in °C or °F.
- **Clinical Thermometer:** Measures body temperature (35°C to 42°C).
- **Laboratory Thermometer:** Measures wider temperature range (–10°C to 110°C).
- **Heat Transfer Modes:** Conduction (solids), Convection (fluids), Radiation (electromagnetic waves).
- **Conductors:** Materials like metals that transfer heat easily.
- **Insulators:** Materials like wood, plastic, wool that resist heat transfer.
- **Sea Breeze:** Cool air from sea to land during day.
- **Land Breeze:** Cool air from land to sea during night.
- **Normal Body Temperature:** Approximately 37°C.

Common Mistakes and Misconceptions

- Assuming sense of touch is always reliable for temperature measurement.
- Using clinical thermometer for measuring non-body temperatures.
- Confusing conduction with convection and radiation.
- Believing all materials conduct heat equally.
- Thinking dark clothes keep you cool in summer.

Glossary

- **Temperature:** A measure of how hot or cold an object is.
- **Thermometer:** Device used to measure temperature.
- **Conduction:** Heat transfer through direct contact in solids.
- **Convection:** Heat transfer through fluid movement.
- **Radiation:** Heat transfer through electromagnetic waves.
- **Conductor:** Material that allows heat to pass easily.
- **Insulator:** Material that resists heat transfer.
- **Sea Breeze:** Cool wind from sea to land during day.
- **Land Breeze:** Cool wind from land to sea during night.