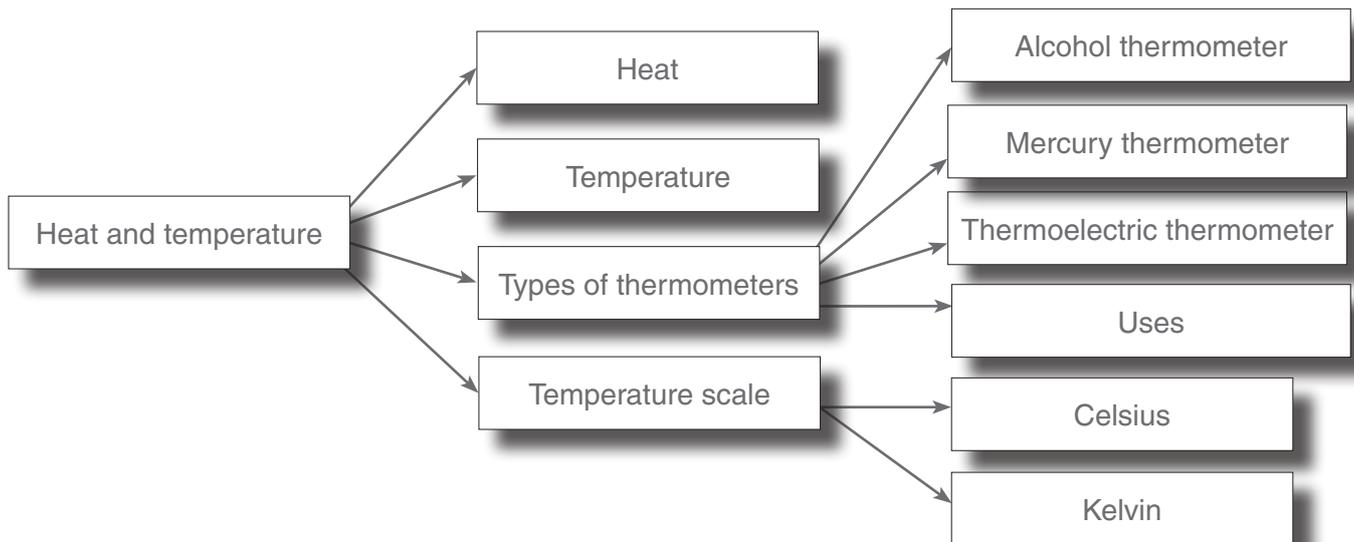


# TERM 4: HEAT AND THERMODYNAMICS

## HEAT AND THERMODYNAMICS



### 1. Heat

Heat is energy that is transferred from one object to another until both objects have the same temperature. It is a form of energy.

We measure heat in joule (J) since it represents an amount of energy.

Heat is energy that is transferred from one object to another.

### 2. Temperature

Temperature is an indication of how hot or cold an object is.



#### Quick facts

The SI unit of temperature is kelvin (K).

Temperature is measured with a thermometer in degrees Celsius ( $^{\circ}\text{C}$ ) or in kelvin (K).

According to the kinetic molecular theory (particle theory) that you studied in Grade 9, hot particles in the solid state vibrate more than cold particles.

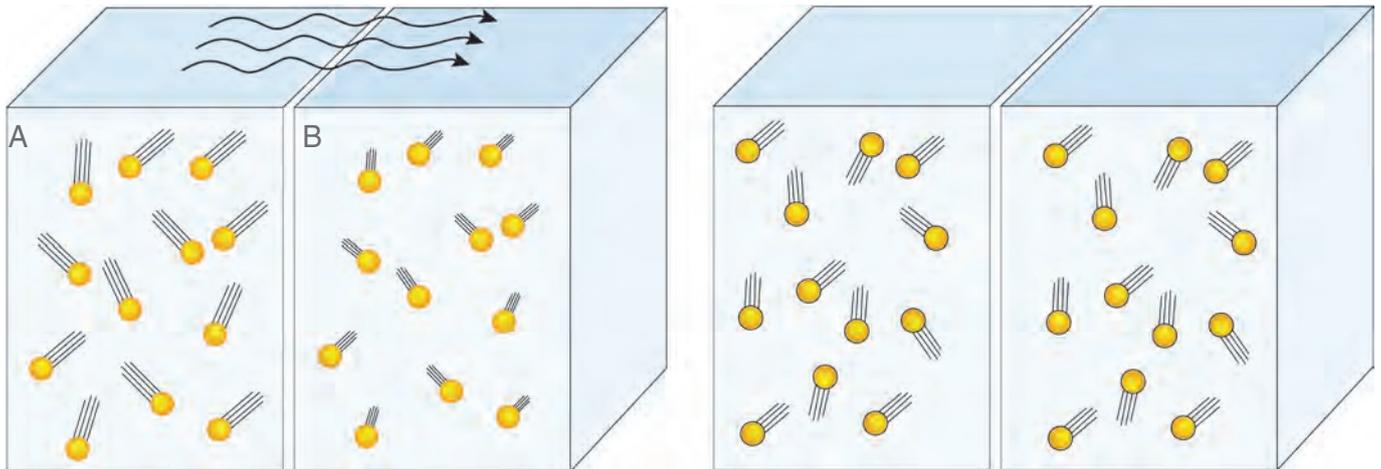
Liquid and gas particles of a given substance move even faster since their temperature is higher than the corresponding temperature of the solid. Temperature is therefore dependent on the kinetic energy of the particles of the substance.



Temperature is a measure of the average kinetic energy of the particles of a substance.

$$E_k = \frac{1}{2}mv^2$$

Study the following two objects of which the temperatures initially differ:



Energy is transferred from the warm object A with a larger average  $E_k$  to the cold object B with a smaller average  $E_k$ . This energy is called heat.

Eventually all the molecules have the same average kinetic energy, so the temperature of both objects is the same.

Object A is hotter and therefore the particles have a greater kinetic energy than those of object B. We know from own experience that both objects would have the same temperature after a while, as represented in the second diagram.

The hot object (A) will become cooler and the cold object (B) will become hotter.

This means that the temperature of the hot object dropped, since heat flowed to the cold object and caused the temperature of the cold object to rise.

## 3 Types of thermometers

There are several types of thermometers.

The most important types are the alcohol thermometer, the mercury thermometer and the thermoelectric thermometer.

### 3.1 Alcohol thermometer

Alcohol thermometers have coloured alcohol (usually red, to make it more visible) inside a narrow tube in a glass casing.

Alcohol is a good choice because it can measure very low temperatures (down to  $-115^{\circ}\text{C}$ ) since the freezing point of alcohol is so low.

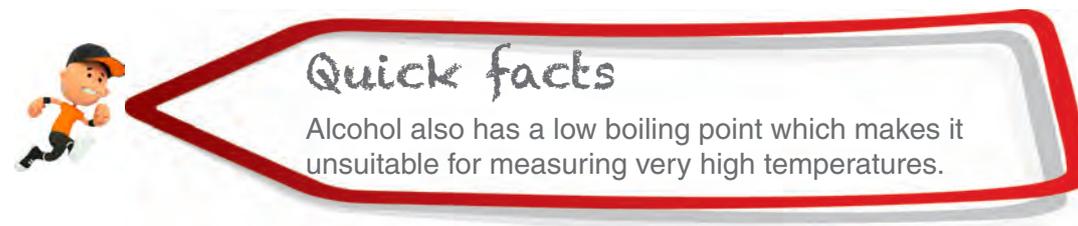
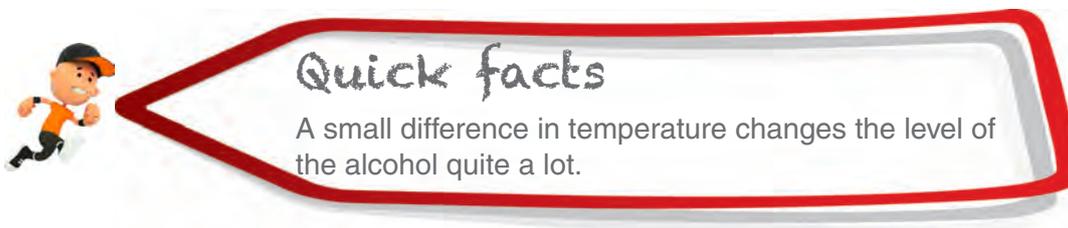


**Advantages:**

- Cheap
- Alcohol expands easily and moderately.
- Accurate readings
- It can measure very low temperatures, down to  $-115^{\circ}\text{C}$ .

**Disadvantages:**

- Alcohol in the thermometer is colourless without colourant.
- Alcohol evaporates easily which could cause inaccuracy.
- Cannot measure high temperatures.
- Alcohol tends to cling to glass which means a correct reading cannot be taken immediately after a drop in temperature.
- Absorbs some of the system's heat, which affects the accuracy of readings.



### 3.2 Mercury thermometer

The mercury thermometer has mercury in a narrow tube in a glass casing. Mercury is visible since it is silver and shiny.

**Advantages:**

- Mercury expands quickly and evenly.
- More accurate readings than the alcohol thermometer
- Mercury does not cling to the glass when the temperature drops.

**Disadvantages:**

- Low temperatures cannot be measured, because the freezing point of mercury is  $-40^{\circ}\text{C}$ .
- Poisonous
- Although the mercury is visible, it is sometimes difficult to see.
- Absorbs the heat of the system and therefore affects the accuracy of readings.





## Quick facts

Mercury is extremely poisonous. If the thermometer breaks it must be handled very carefully.

### 3.3 Thermoelectric thermometer

The thermoelectric thermometer is the most accurate of the three types. It has a thermocouple which consists of two different types of metalloids.

One part of the thermocouple is always at a constant cold temperature and the other part is where the reading is taken. It is usually warmer.

The difference in temperature of the thermocouple causes an induced emf which is then converted into a temperature reading. The larger the induced emf, the higher the temperature.

Advantages:

- Very accurate
- Does not absorb the system's heat.
- Does not affect the system's temperature.
- Digital scale is easier to read.



## Quick facts

Thermoelectric thermometer can measure very accurately over a large range of temperatures (0,001 K – 2 000 K).

### 3.4 Uses

Thermometers are used for a variety of purposes in everyday life. The following are examples thereof:

- To measure the temperatures of the atmosphere
- To determine the temperatures of ovens
- Aeroplanes must determine, by monitoring the temperature of the wings, whether defrosting of the wings is required.
- The temperature of roads in countries where it snows a lot will determine whether salt is necessary on the roads.
- Maximum-minimum thermometers are used to measure the temperatures for different weather conditions.
- Clinical thermometers are used to determine whether a patient has a fever or not.