

# Chapter 14: Temperature and Thermometers

**Def: Temperature is a measure of the hotness or coldness of a body.**

**Unit of Temperature: Kelvin (K)**

Temperature is really a measure how quickly atoms or molecules in an object are moving or vibrating; the colder the temperature the more sluggish the molecules move.

The S.I. Unit of temperature is the **Kelvin**. Temperatures expressed in Kelvin are symbolised by  $T$ . We usually use **degrees Celsius**, symbolised by  $t$ .

Both scales are related.

$$0\text{ }^{\circ}\text{C} = 273.15\text{ K} \quad \text{and} \quad 100\text{ }^{\circ}\text{C} = 373.15\text{ K}$$

1  $^{\circ}\text{C}$  is the same as 1 K

Convert from K to  $^{\circ}\text{C}$  : subtract 273.15

Convert from  $^{\circ}\text{C}$  to K : add 273.15

## Thermometric Properties

**Def: Any physical property that changes measurably with temperature is called a thermometric property.**

The instrument used to measure temperature is called a **Thermometer**.

## Examples of Thermometric Properties

### 1. Length of a column of liquid.

Mercury-in-glass thermometer: Liquids expand (volume increases) when heated. If this liquid is in a capillary tube, the length of the column increases as the liquid expands.

### 2. Electrical Resistance.

Electrical resistance in a conductor increases with temperature.

Metal: resistance **increases** with increasing temperature

Semiconductor/carbon: resistance **decreases** with increasing temperature

A thermistor is an example of this. (chapter 23)

### 3. Emf (voltage) of a thermocouple.

2 metals joined to form a circuit. If both junctions are kept at different temperatures, a small emf appears in the circuit. Greater the temperature, greater the emf.



## 4. Colour

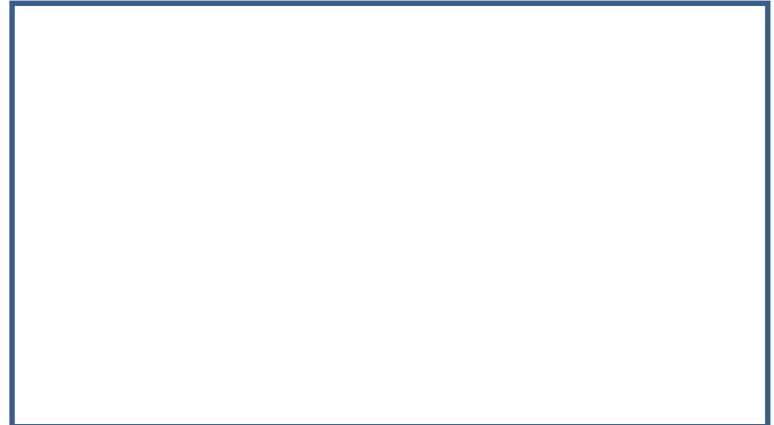
The colour of materials change with temperature. Iron changes from brown to red to yellow to white.

Use: plastic strip thermometers  
filament in a bulb  
detecting the temperature in a volcano/furnace.

## 5. Volume of a gas at constant temperature.

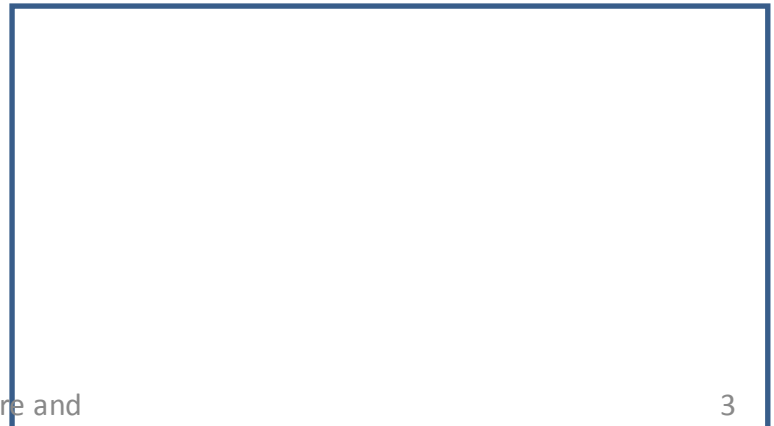
A gas syringe with a fixed mass with a rubber seal at one end.

Once the temperature of the gas is increased, the piston is pushed out. If it is cooled, the piston is pushed in.



## 6. Pressure of a gas at constant volume.

A gas syringe is set up as in the diagram and the volume is noted. As the gas is heated, the volume is increased. To keep it constant, weights are added to the top of the piston.



## Using a Thermometric Property to Measure Temperature

- Using an ungraduated mercury thermometer (length of mercury is the thermometric property), place it in a beaker of melting ice ( $0\text{ }^{\circ}\text{C}$ ). Mark the position of the mercury.
- Place the thermometer above steam of pure water ( $100\text{ }^{\circ}\text{C}$ ). Mark the position of the mercury.
- Measure the lengths of mercury.  $L_{\text{ice}}$  and  $L_{\text{steam}}$
- Plot the 2 points on a graph and join them.
- The temperature corresponding to any length can be found from the graph.

## **Disagreement between Thermometers.**

If 2 different thermometers are created this way, both will give temperatures at  $0\text{ }^{\circ}\text{C}$  and  $100\text{ }^{\circ}\text{C}$ . However, for all other temperatures, they will disagree.

Reason: different thermometric properties do not change proportionally with the same degree of hotness. (each thermometer works on its own scale)

Therefore we need a standard thermometer to get the true value. In school, we use the mercury-in-glass thermometer.

## **Practical Thermometers.**

Clinical thermometer, oven thermometer and car temperature gauges.

Clinical Thermometers: Short range of reading. Has a small constriction at the bottom to stop the mercury falling after being removed from the body.

Other clinical thermometers:

Infra-red radiation thermometer – measures the temperature (infra-red radiation) from the ear drum

Plastic strip thermometer.