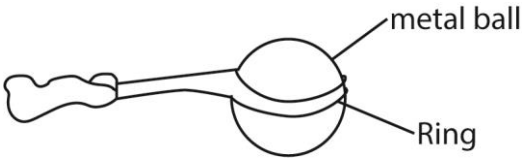
**S1 New Curriculum Physics**

**Theme: Heat**

**Chapter 7 – Expansion of solids, liquids and gases**

**Expansion**
This is the increase in size of matter in all directions whenever matter is heated.

**Expansion in Solid.**




- Before heating, the metal ball passes through the ring easily
- After heating the metal ball does not pass through the ring showing that when the metal ball (Solid) was heated, it expanded.
- When the metal ball cooled, it was found to pass through the ring. This indicated that on cooling the metal ball (Solid) contracted.

**Metals expand by different amounts**


When the bimetallic strip of Iron and Brass is heated, it bends with brass on the outside of the curve. This is because Brass expands more than Iron.
Bimetallic strips are useful in the following devices by completing the metallic circuit

(i) ringing alarm bells
(ii) thermostats

**Linear Expansivity**

**Linear expansivity** refers to the fractional increase in length of a material per unit length per degree rise in temperature. It is a key concept in thermal expansion, helping engineers and scientists predict how materials behave under temperature changes.

## Formula:

The coefficient of linear expansion (α) is given by: $\alpha = \frac{\Delta L}{L_0 \Delta T}$

Where:

- **ΔL** = Change in length
- **$L_0$** = Original length
- **ΔT** = Change in temperature

**Application of expansion of solids**

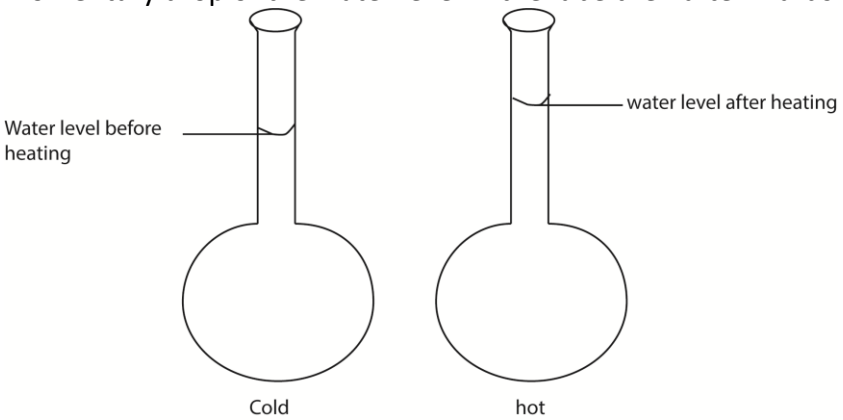
(i) **Railway tracks**: Gaps are left between rails to accommodate thermal expansion, preventing warping and misalignment.
(ii) **Bridges and buildings**: Expansion joints allow structures to expand and contract with temperature changes, reducing stress.
(iii) **Electrical wires**: Overhead power lines are installed with slack to prevent breakage due to contraction in cold weather.
(iv) **Bimetallic strips**: Used in thermostats and temperature-sensitive devices, these strips bend due to different expansion rates of metals.
(v) **Automobile engines**: Pistons and cylinders expand when heated, ensuring proper function and efficiency

**Expansion of liquids**

Liquids expand when they are heated. Different liquids expand by different amounts when equally heated. Liquids expand much more than Solids because according to the Kinetic theory, liquid molecules are far apart compared to those of solids and the intermolecular forces are weaker in liquids.

**Experiment to demonstrate expansion of water**

When the round bottomed flask is placed in hot water as shown, initially there will be a momentary drop of the water level in the lube then after-wards the level rises.



**Explanation**
When the flask is in hot water, the flask first receives heat before the water in it so the flask expands and its volume increases causing the slight fall in level. However, on receiving the heat, the water expands more than the increase in volume of the flask.

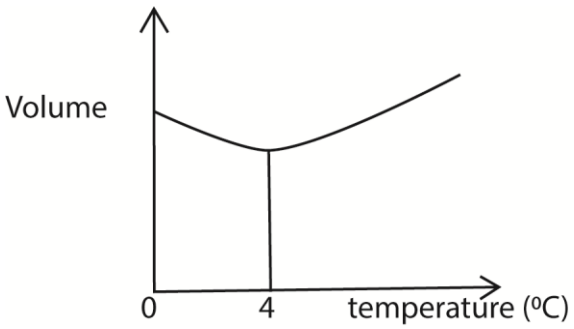
**Applications of expansion of liquids**

The **expansion of liquids** has several practical applications in daily life and industry. Here are some key examples:

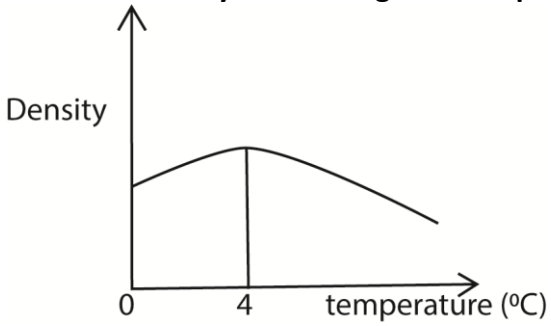
- **Thermometers**: Liquids like mercury and alcohol expand with temperature changes, allowing accurate measurement.
- **Car engine cooling systems**: Coolants expand when heated, helping regulate engine temperature.
- **Hot air balloons**: Heated air expands, reducing density and allowing the balloon to rise.
- **Cooking and food processing**: Liquids expand when heated, affecting boiling points and cooking efficiency.
- **Industrial processes**: Liquid expansion is considered in chemical reactions, fuel storage, and hydraulic systems.

**Anomalous expansion of water (Unusual expansion of water)**
For all Solids except ice, when they melt to form liquids they expand just after melting but Ice which melts at $0^0$C to form water contracts until 4°C. Water is thus exceptional or anomalous in the range 0°C to 4°C

**Sketch of volume against temperature**




From the sketch it is noted that water has its minimum volume at $4^0$C
**Sketch of density of water against temperature**



Since density is mass/volume but mass is unaltered by warming. It is only volume which decreases from O°C to 4°C. It follows that water has its maximum density at 4°C.

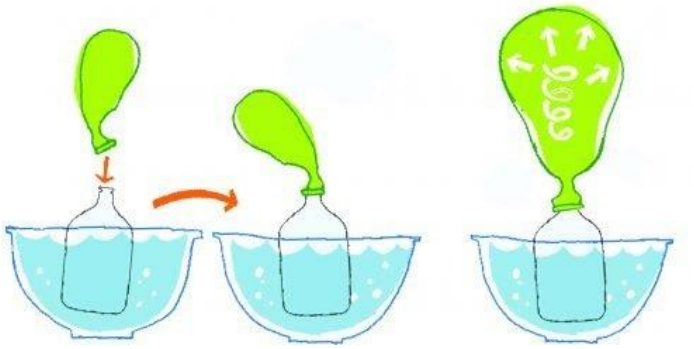
**Biological Importance of abnormal expansion**

Ice is less dense than water so it floats on water. Ice insulates water bodies during winter preventing further solidification of water. This protects aquatic organisms from freezing

**Expansion of gases**

Like liquids and solids gases expand when heated although, the expansion of gases is far much greater. This is because molecules in gases have weak intermolecular forces, so they easily get broken when heated.

**Experiment to demonstrate expansion in gases**



(i) Fill two bowls—one with **cold water** and the other with **hot water**.
(ii) Place an **empty plastic bottle** in the cold water for a minute.
(iii) Fit a **balloon** over the bottle's opening.
(iv) Now, place the bottle into the hot water.
(v) Watch the balloon **expand** as the gas inside the bottle heats up and expands.

**Applications of expansion in gases**

(i) **Hot air balloons**: Heated air expands, reducing its density and allowing the balloon to rise.
(ii) **Internal combustion engines**: Fuel combustion causes gas expansion, driving pistons and generating power.
(iii) **Air conditioning and refrigeration**: Gases expand and contract to regulate temperature in cooling systems.
(iv) **Weather phenomena**: Atmospheric expansion influences wind patterns, storms, and cloud formation.
(v) **Jet propulsion**: Expanding gases in jet engines create thrust, enabling aircraft to fly.

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