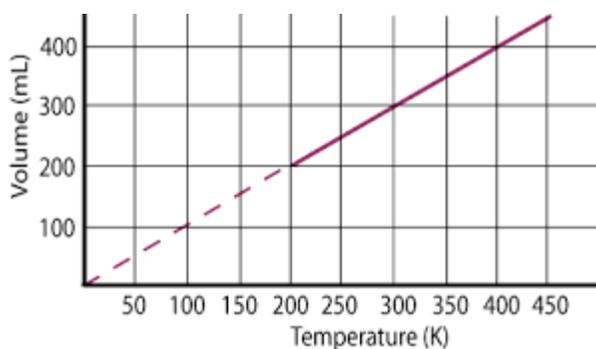


Thermal properties and temperature

Thermal expansion of solids, liquids and gases at constant pressure-Charles law:

For a fixed mass of a gas at constant pressure, the volume is directly proportional to the Kelvin temperature.

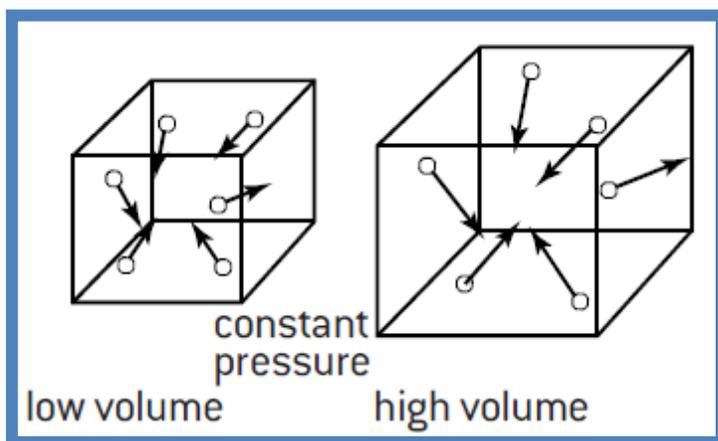
$$V \propto T \Rightarrow \frac{V}{T} = \text{CONSTANT}$$



Note : It is important to keep pressure constant while measuring thermal expansion of solids, liquids and gases because a change in pressure also causes a change in volume.

Understanding Charles law at a macroscopic level:

- At higher temperature the molecules move faster. Faster moving molecules hit the walls with greater force.



- If the volume of the gas increases, then the rate at which these collisions take place per unit area reduce. The average force on a unit area of the wall of the container can thus be the same.

Explanation of the relative order of magnitude of thermal expansion of solids, liquids and gases:

- Solids, liquids and gases expand when heated.
- Magnitude in thermal expansion means how much the substance can expand.
- The relative order of magnitude of thermal expansion is: *solid* < *liquid* < *gases*.

Expansion of solids:

The particles in a solid are closely packed and have strong intermolecular forces of attraction between them. So when a solid is heated, the kinetic energy of the molecules increases and the intermolecular distance increases a little and hence there is a very small overall increase in the dimension of the solid.

Expansion of liquids:

The particles in a liquid are not as closely packed as compared to solids. Their intermolecular forces of attraction are weaker compared to solids. So when a liquid is heated, the kinetic energy of the molecules increases and the intermolecular distance increases a little and hence there is an increase in the volume of the liquid.

Expansion of gases:

The particles in a gas are much further apart compared to solids and liquids. Their intermolecular forces of attraction are the weakest. So when a gas is heated, the kinetic energy of the molecules increases and the intermolecular distance increases to a great extent and hence there is an increase in the volume of the gas.

Consequences and applications of thermal expansions:

- A jar with a tight fitting lid can be opened by warming the lid. The heat expands the lid and it becomes easier to unscrew the lid.
- Expansion gaps are left in railway tracks and bridges. The gaps are fitted with soft material such as rubber.
- Steel tyres on train wheels are fitted by heating the tyre and then fitting them on wheels. The tyres fit tightly once they contract.
- Bimetallic strips are used in thermostats. The bimetallic strip consists of two different types of metals joined together. When the temperature of the strip rises, one metal expands more than the other and the strip bends.