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P10 Thermal properties of matter

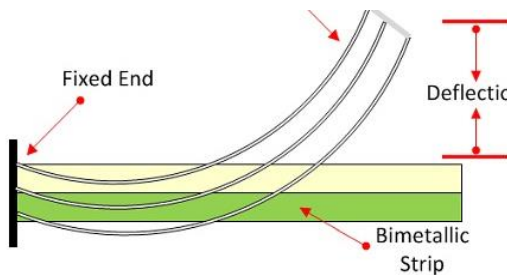
P10.01 thermal expansion

Thermal expansion: most substances expand when they are heated

1. Uses of expansion



- When lid sticks on a glass jar
- Heat the lid, which causes it to expand
- Glass loosens lesser than lid
- Lid loosens and removed



- When it's hot, it bends
- One metal expands more rapidly than the other
 - One is longer than other one
- Used in fire alarms

$$P V = n R T$$

Volume, m³ (points to V)
 Pressure, Pa (points to P)
 moles (points to n)
 Temperature, K (points to T)
 Ideal Gas Constant – 8.31 J/K/mol (points to R)

2. Consequences of expansion

Bridge might buckle

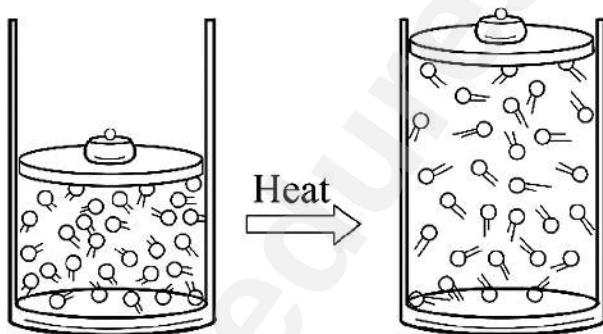
- Use sections, so that the gaps between section decreases

Railway, glass

- Glass is fragile, because inner surface of glass expands more rapidly before heat is conducted to outer surface of glass
- Use materials which expand very little

3. The expansion of gases

If piston is not moved, volume remains, But pressure increases



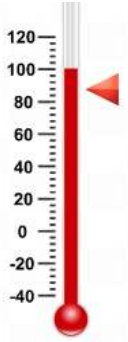
- When gas gets heat, particles move faster
- Greater force pushes piston upwards

4. Comparing solids, liquids and gases

When material expands, they have more energy, they move around more and **take up more space**.
 solid does not expand much, but gas is more easy to push each other, so takes up more space

- Solids expand most slowly when heated
- Liquid expand faster than solids
- Gases expand much faster

P10.02 Temperature and temperature scales



1. Energy from the patient is shared with the thermometer
2. Molecules of hot water are rushing, colliding with the thermometer more often and shares energy
3. **Thermal equilibrium** - temperature when energy is not being transferred from one to the another

1. Temperature and internal energy

Internal energy: total energy of all of the particles

Temperature: measure of the average kinetic energy of the individual particles

2. The celsius scale

- 0°C - the freezing point of pure water at atmospheric pressure
- 100°C - the boiling point of pure water at atmospheric pressure

P10.03 Designing a thermometer

Good thermometers

- **Fixed points:** definite temperatures at which something happens and are used to calibrate a thermometer. For example, melting and boiling point of water
- **Sensitivity:** Change in length or volume per degree
- **Range:** The values which can be measured using the thermometer
- **Linearity:** Uniform changes in the physical property with a change in temperature over the measured temperature values.
- **Responsiveness:** How long it takes for the thermometer to react to a change in temperature
- **Calibrating** a thermometer:
 - Place thermometer in melting ice, this is 0 °C.
 - Place thermometer in boiling water, this is 100 °C.

Mercury

- Expands at steady rate - **linear scale** available
- Mercury has wider range → -39°C ~ 350°C

Thermocouple

Thermocouple: device that gives an output voltage that depends on the temperature

- Made from two pieces of wire from two different metals
- One is put in 0 °C, other is in the 목표 object
- More bigger temperature difference => higher voltage

advantage

- Do not absorb much energy from the 목표 object
- Can be used to measure high temperature
- They can heat up and cool down quickly