Topic 12 Thermal properties of materials

Summary

- Melting, boiling and evaporation are all examples of changes of phase (solid to liquid, and liquid to vapour).
- All these changes of phase require an input of energy (latent heat) to overcome the interatomic forces.
- Boiling takes place at a fixed temperature for a particular atmospheric pressure, but evaporation occurs at all temperatures. Boiling occurs in the body of the liquid; evaporation occurs at its surface.
- In a solid, the interatomic spacing is of the order of 10^{-10} m.
- Specific heat capacity is numerically equal to the heat energy required to raise the temperature of unit mass of substance by one degree. The SI unit of specific heat capacity is J kg^{-1} K^{-1}.
- The heat energy ΔQ required to raise the temperature of a mass m of substance of specific heat capacity c by an amount $\Delta\theta$ is given by the expression: $\Delta Q = mc\Delta\theta$
- The heat capacity of an object is numerically equal to the heat energy required to raise the temperature of the whole body by one degree. The SI unit of heat capacity is J K^{-1}.
- The heat energy ΔQ required to raise the temperature of an object having a heat capacity C by an amount $\Delta\theta$ is given by the expression: $\Delta Q = C\Delta\theta$
- Specific latent heat of fusion is numerically equal to the quantity of heat energy required to convert unit mass of solid to liquid without any change in temperature.
- Specific latent heat of vaporisation is numerically equal to the quantity of heat energy required to convert unit mass of liquid to vapour without any change in temperature.
- When a substance of mass m changes its state the quantity of heat energy required is given by $\Delta Q = mL$ where L is the appropriate specific latent heat.
- Specific latent heat has the SI unit of J kg^{-1}.
- The internal energy of a system is the sum of the random kinetic and potential energies of the various parts of the system. For an ideal gas, the internal energy is the total kinetic energy of random energy of the molecules. Internal energy is a measure of the temperature of the system.
- The first law of thermodynamics expresses the law of conservation of energy. The increase in internal energy ΔU of a system is equal to the sum of the heat q added to the system and the work w done on it:

  $$\Delta U = q + w$$

  (Sign convention: positive q, heat is added to the system; positive w, work is done on the system; positive ΔU, increase in internal energy.)

Definitions and formulae

- Specific heat capacity is the amount of heat energy required to raise the temperature of unit mass by one degree.
- c = energy supplied/(mass × temperature change)
- Specific latent heat of fusion is the heat energy required to convert unit mass of a solid to liquid without a change in temperature.
- Specific latent heat of vaporisation is the heat energy required to convert unit mass of liquid to a vapour without a change in temperature.
- Internal energy of a system = the sum of all the molecules' random kinetic and potential energies.
- The first law of thermodynamics states that the *increase* in internal energy of a system is equal to the heat energy absorbed *by* the system plus the work done *on* the system.