Chapters 12-15

Thermodynamics

Introduction

Thermodynamics

- Deals with very practical phenomenon, e.g., engines, power generation systems
- →The study of heat and work and the transformation of one into the other
- Based on observations of energy exchanges between macroscopic systems
- Macroscopic systems with very large numbers of particles → in 1 m³ there are over 10²⁵ air molecules

Equilibrium of mechanical systems: the concept of temperature

- Three parameters were needed to describe the motion and equilibrium states of bodies → *length, mass, and time*
- To describe thermal or heat effects in systems we need another fundamental parameter → temperature: T

Macroscopic Parameters

- The macroscopic parameters are those that can be measured directly temperature, pressure, volume
- The macroscopic parameters reflect the average behavior of the microscopic constituents of the system, for example, the velocities of the molecules which cannot be directly measured
- Newton's laws cannot be used to solve problems involving 10²³ particles









Laws of Thermodynamics

• First Law The transformation of heat into work obeys the Principle of conservation of energy

- Second Law
 - The heat going into an engine cannot all be converted to work, some heat is wasted
 - Heat flows spontaneously from hot to cold, (ice always melts when placed in water); and work must be done to make heat flow from cold to hot (refrigerators)

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Heat

- Heat is the *energy that flows* from one system to another system because one is hotter than the other
- Heat flows from the hot system (lowering its internal energy and temperature) to a cold system (raising its internal energy and temperature).
- Heat stops flowing when the two systems reach a common temperature.

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- The molecules in a system, like a gas, are in constant motion. Each molecule has a kinetic energy ½ mv². The KE of an individual molecule cannot be measured
- The *internal energy* of a system is the sum of all the kinetic energy of all the molecules in the system





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• YES--- the Kelvin Scale











