

The Nature of Thermodynamics

Thermodynamics applies to **macroscopic** systems.

It rests essentially on three principles and does not depend upon any model of matter.

Unlike, for example, mechanics or electromagnetism, thermodynamics applies to many different types of systems. But because of its general character, thermodynamics cannot predict specific values of observable quantities.

However, this general character allows to

- say if a physical process is permissible or not,
- establish relationships among apparently unrelated properties,
- indicate the sign of some physical quantities like heat capacities or susceptibilities,
- prove inequalities as, for example, between the isothermal and isentropic magnetic susceptibilities...

Few important dates

Galileo (1564-1642) constructs first thermometers using thermal expansion.

Fahrenheit (1686-1736) uses mercury in thermometry.

Black (1728-1799) distinguishes heat from temperature (heat is conserved ?!!).

Rumford (1753-1814) and **Davy** (1778-1829) have the intuition of a more general conserved quantity.

Mayer (1814-1878) determines J , the equivalent in joules of one calorie, in 1842.

Joule (1818-1889) and **Helmholtz** (1821-1894) make more precise measurements of J .

Watts (1736-1819) invents the steam engine.

Carnot (1796-1832) discovers the principles of steam engines, presented in a very small volume entitled: *Réflexions sur la puissance motrice du feu et sur les machines propres à développer cette puissance*, published in 1824.

Clausius (1822-1888) shows that it is impossible to construct steam engines that transform integrally heat into mechanical work.

Historically, the equivalence between heat and mechanical work, conservation of energy, and heat engines have played a role of great importance in the development of thermodynamics. In these notes, in order to stress the the simplicity of the ideas on which thermodynamics is premised, and its wide applicability, we shall adopt a more modern and completely different presentation.