**Thermodynamics**:

Thermodynamics is one of the most philosophical chapters of physics proving that it is impossible to go back in time, to increase the diversity of a physical system.

The equations of thermodynamics are widely used in physics and even in economics.

The **temperature** is directly proportional to the average kinetic energy of the particles of the physical system.

K = C + 273.

The **pressure** is directly proportional to the average velocity of the particles of the physical system.

Exploring, which clothes is warmer, black or white, brings us to the problem of the **absolutely black body** which absorbs and radiates the whole spectrum.

Bodies expand when they are heated. The equation for the expansion is ∆L = αTL0. Here L0 is the original length of the body; ∆L is the change in length and α is a constant of thermal expansion.

Usually, α is a very small number compared to one, thus, the approximate equation of the increase of the volume due to the heat is as follows: ∆V = 3αTV0. Here V0 is the original volume and ∆V is the change in the volume.

**Ideal gas** is a model, which considers the particles infinitely small and neglects the interactions between the particles.

The ideal gas equation is as follows:

PV = nRT

It links pressure (P), volume (V) and temperature (T).

Here n is the number of moles R is a constant.

For the real gas (when the sizes of the particles are finite and the interactions of the particles are taken into account) there is Van Der Waals equation, which is more general equation than the ideal gas equation, which can be derived from Van Der Waals equation as a particular case (when the sizes of the particles and the forces of interactions between the particles go to zero).

One **mole** of a substance is the number of grams equal to atomic mass or molecular mass.

**Avogadro’s number** NA = 6.02×1023 is the number of atoms in one mol of a substance.

PV = NkT,

Here N is the number of particles and k is the constant of Boltzmann.

<KE> = 0.5m<v>2 = 1.5kT

**Saturated vapor** **pressure, relative humidity, triple point** are important concepts of thermodynamics which is needed to understand the balance between evaporation, condensation and boiling.

**Diffusion** occurs due to different concentrations, which is similar to the heat transfer if there is a difference in temperatures. Mathematically, diffusion and heat equations are the same.

**Internal energy** U = 1.5NkT = 1.5nRT

Q = cmT

The **heal balance equation** gives the final temperature as a weighted average of the original temperatures of the subsystems.

The heat balance equation is similar to other weighted averages equations such as the collision equations or the center of mass equation, or the center of gravity equation of the classical mechanics.

The **thermal capacity** (C) of a substance is the amount of heat energy necessary to increase the temperature of one kilogram of a substance by one degree.

For two thermally isolated subsystems of masses m1 and m2, temperatures T1 and T2, and the thermal capacities C1 and C2, the resulting temperature

$$T=\frac{C\_{1}m\_{1}T\_{1}+C\_{2}m\_{2}T\_{2}}{C\_{1}m\_{1}+C\_{2}m\_{2}}$$

This formula is true not only from two subsystems but also for any number of subsystems.

The **heat equation** and the **diffusion equation** are mathematically very similar to Black-Scholes equation in economics.

**Calorimetry** is a quantitative measure of heat exchange.

**Fusion heat**

**Vaporization heat**

The heat is transferred by **conduction**, **convection** and **radiation**.

The **First Law of Thermodynamics** is conservation of energy.

U = Q – W

**Isothermal**

**Isobaric**

**Isochoric**

**Adiabatic**

W = VP

**Heat engine**

e = W/QH = 1 – QL/QH

eideal = 1 – TL/TH

The efficiency of a **heat engine** is limited even theoretically to approximately 40% whereas in reality the efficiency is even smaller.

**Refrigerator or air-conditioner**

COP = QL/W

Heat pump

COP = QH/W

The **Second Law of Thermodynamics** says that the diversity of a physical system cannot increase over time or the temperature of the whole physical system will eventually be the same (weighted average of all of the original temperatures of the subsystems of the system).

S > 0

**Thermal pollution** is a side-effect of the heat engines.

The **computing thermodynamics** says that classical computers are extremely limited and we need to use quantum computers or atomic computers, or molecular computers, or nuclear computers, or something like that to improve the calculating capacity of our computers in the near future.