# Chapter 1: Summary

1. A thermodynamic system typically consists of $N \sim 10^{23}$ particles. However, the physical state of a thermodynamical system is described by a set of only a few variables such as $P, V$ and $T$ etc. for a gas.

2. Thermodynamic quantities are divided into two classes, extensive (proportional to $N$) and intensive (independent of $N$).

3. State functions in thermodynamics are a function of thermodynamic variables. Hence, a change of a state function only depends on the initial and final states and independent of the details of the process. Internal energy $E$ is a state function.

4. Any gas at dilute limit and high temperature can be considered as an ideal gas, in which interaction between molecules are ignored. An ideal gas has two basic properties: its equation of state (a relation between its variables) is
$$PV = Nk_BT = nRT$$
and its internal energy is a function of $T$ only, namely $E = E(T)$.

5. A van der Waals gas is described by the following equation of state
$$\left(P + a\frac{n^2}{V^2}\right)(V - nb) = nRT$$
which has included some effects of molecular interactions.

6. First law of thermodynamics is a statement of energy conservation
$$dE = đQ + đW$$
namely the energy change of a system in a process is equal to the heat absorbed by the system ($đQ$) plus the work done on the system ($đW$). Note that $Q$ and $W$ are not a state function and hence their changes are process dependent.

7. There are two heat capacities:

   $$C_V \equiv \left(\frac{đQ}{\partial T}\right)_V = \left(\frac{\partial E}{\partial T}\right)_V$$

   at constant volume and

   $$C_P \equiv \left(\frac{đQ}{\partial T}\right)_P = \left(\frac{\partial E}{\partial T}\right)_P + P\left(\frac{\partial V}{\partial T}\right)_P$$

   at constant pressure.

8. A reversible process: quasistatic and no friction.
   An adiabatic process: no heat exchange (i.e., $\Delta Q = 0$).
   A cycle process: initial and final states are the same hence $\Delta E = 0$.