PH2202: Thermal Physics

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1 Introduction

The course introduces us to the fundamentals of thermal physics and will end with statistical physics.

2 Internal energy of Ideal Gas

We use some elementary equations already taught in CH1201. We will be using the ideal gas equation and the 1^{st} Law of Thermodynamics.

$$PV = NRT$$
$$dU = TdS - pdV + \mu dN$$

We assume the fact that the internal energy of the system, something we will define later, depends on the variables entropy(S), volume(V) and no of moles(N). The first term of equation 2 above change in heat energy $dQ = TdS$ and work done on the system $dW = -PdV$ and chemical potential μdN.

$$dU = \frac{\partial U}{\partial S}dS - \frac{\partial U}{\partial V}dV + \frac{\partial U}{\partial N}dN$$
$$T = \frac{\partial U}{\partial S}dS \qquad \text{(Comparing this to the first law)}$$
$$P = -\frac{\partial U}{\partial V}dV$$
$$\mu = \frac{\partial U}{\partial N}dN$$

The chemical potential is a new term added in this course. So chemical potential essentially refers to the change in internal energy on adding or subtracting a molecule. Essentially when we add an infinitesimally small number of molecules say dN, we have the chemical potential term to be μdN.

$\boxed{\text{Goal: We need to find a closed form expression for the internal energy of an ideal gas}}$

We introduce one more equation into solving for the closed form expression i.e. the equipartition of energy.

$$U = \frac{3}{2}NRT$$
$$\Rightarrow T = \frac{2U}{3NR}$$