1.1 Introduction

Thermodynamics is a nearly unique branch of science because it nearly needs no assumptions.
So for example Albert Einstein stated: "Classical thermodynamics is the only physical theory of universal content, which I am convinced, that within the framework of applicability of its basic concepts will never be overthrown".
Most of the axioms of classical thermodynamics can be proven using a statistical approach as will be done in a later section. Before we will study the axioms of thermodynamics in detail we will discuss the properties of a perfect (ideal) gas so that we have a working horse for illustrating the meaning and consequences of the axioms. However, the perfect gas is not just *one* simple example of a thermodynamic system, it is *the* example for classical particles, since it introduces the concept of *free particles.* As we will learn, the thermodynamic properties of free electrons, free bosons, and free classical particles (the perfect gas) provide a fundamental set of equations all materials scientists should memorize by heart. Non-free particles, i.e. interacting particles, are often described by slightly varying the equations for the corresponding free particles. Several of these approaches will be introduced in this first chapter to describe real gases (and fluids), all starting from the equations for the perfect gas. In this lecture many concepts of thermodynamics will be introduced which hold for classical particles, i.e. particles which can be described without using quantum mechanics. This is necessary because quantum mechanics just adds another degree of complexity to thermodynamics which is not useful for introducing the concepts of thermodynamics. Thus later on when discussing thermodynamic properties of quantum mechanical particles the similarities as well as the deviations from the properties of classical particles will become more clear.