# Physical Chemistry

## Peter Atkins

## (Sixth edition)

*Bilingual Program*

# Part 1: Equilibrium

# Part 2: Statistics

# Part 3: Change

# An Outline

## Part 1: Equilibrium

1. The properties of gases
2. The First Law: the concepts
3. The First Law: the machinery
4. The Second Law: the concepts
5. The Second Law: the machinery
6. Physical transformations of pure substances
7. Simple mixtures
8. Phase diagrams
9. Chemical equilibrium
10. Electrochemistry

# An Outline

## Part 1: Equilibrium

## Part 2: Statistics

## Part 3: Change

# An Outline

## Part 2: Statistics

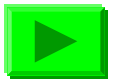
11. Quantum theory: introduction and principles
12. Quantum theory: techniques and applications
13. Atomic structure and atomic spectra
14. Molecular structure
15. Molecular symmetry
16. Spectroscopy 1
17. Spectroscopy 2
18. Spectroscopy 3
19. Statistical thermodynamics: the concepts
20. Statistical thermodynamics: the machinery
21. Diffraction techniques
22. The electric and magnetic properties of molecules
23. Macromolecules and colloids

# An Outline

## Part 1: Equilibrium

## Part 2: Statistics

## Part 3: Change



# An Outline

## Part 3: Change

24. Molecules in motion

25. The rates of chemical reactions

26. The kinetics of complex reactions

27. Molecular reaction dynamics

28. Processes at solid surfaces

29. Dynamic electrochemistry

# An Outline

Following each chapter, there are Exercise and Problem sections. An Exercise is a straightforward, direct application of an item in the text. A problem is more complex and may draw on the literature. The further problems are summarized in Micro-Projects in the end of each Part. These Micro-Projccts are designed to draw on knowledge from all the chapters in each part. The MicroProjccts are intended to be helpful when reviewing the material of each part of the text, and also provide some interesting applications.

# Part 1: Equilibrium

## 0. Introduction

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# Introduction

**Physical chemistry is the branch of chemistry that develops principles of the subject. Its concepts are used to explain observations on the physical and chemical properties of matter. Physical chemistry is also essen-tial for developing and explaining the modern techni-ques used to determine the structure and properties of matter, such as new synthetic materials and biological macromolecules.**

**In this section, we will concentrate on concepts of:**

- **Matter and Energy**
- **System and its surroundings**
- **State and Equations of states**

# 0. Basic concepts

## 0-1 Fundamentals

1). **Law:** a summary of experience.

2). **Hypothesis:** a guess at an explanation in terms of more fundamental concepts.

3). **Model:** a simplified version of the system that focuses on the essentials of the problem.

## 0-2 Matter

### 1). Substance:

A substance is a distinct, pure form of matter. The amount of substance, ***n***, in a sample is reported in terms of a unit called a mole (mol). The formal definition of 1 mol is that it is the amount of substance that contains as many objects as there are atoms in exactly 12 g of carbon−12. This number is found experimentally to be around $6.02\times10^{23}$. If a sample contains $N$ entities, the amount of substance it contains is $n = N/N_A$, where $N_A$ is the Avogadro constant: $N_A = 6.02\times10^{23}\ mol^{-1}$. Note that $N_A$ is not a pure number.

# 0. Basic concepts

## 0-2 Matter

### 1). Substance:

### 2). Intensive property:

a property that is independent of the amount of the substance.

### 3). Extensive property:

a property that depends on the amount of the substance.

## 0-3 Energy

The central concept of all explanations in physical chemistry is that of energy. Briefly, energy is the capacity to do work.

There are two contributions to the total energy of a system from the matter it contains. The kinetic energy and the potential energy.



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## 0-3 Energy

### 1). Kinetic energy:

the energy it possesses as a result of its motion.

### 2). Potential energy:

the energy it possesses as a result of its position.

### 3). The unit of energy:

Joule (J), SI unit; 1 J = 1 kg $m^2$ $s^{-2}$.




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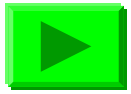
## 0- 4 Systems and surroundings

For the purposes of physical chemistry, the universe is divided into two parts, the system and its surroundings. The system is the part of the world in which we have a special interest. The surroundings are where we make our measurements. The type of system depends on the characteristics of the boundary that divides it from the surroundings.



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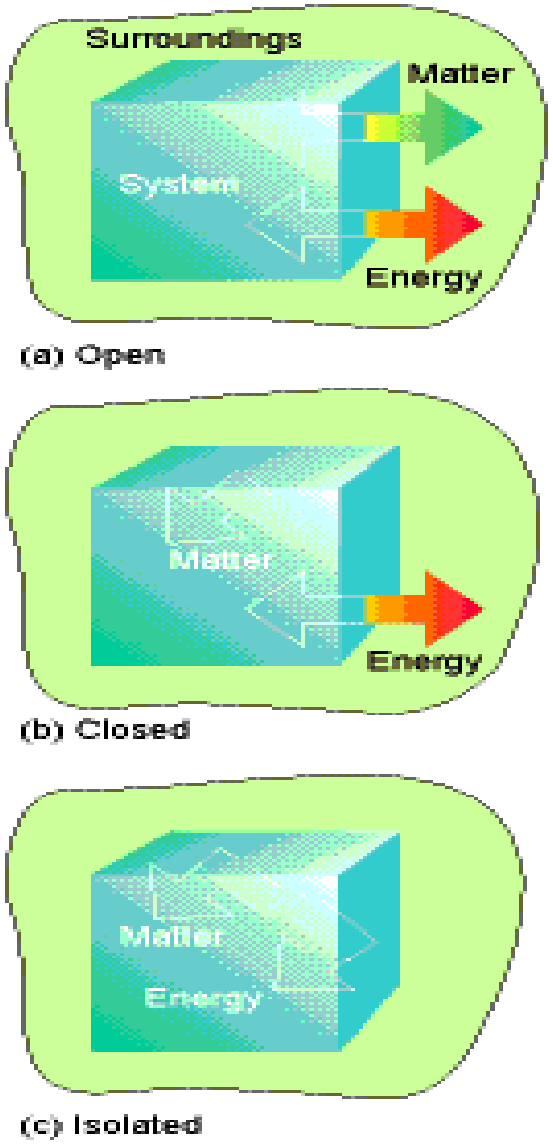
# Systems




## (a). An open system:

can exchange matter and energy with its surroundings.

## (b). A closed system:

can exchange energy with its surroundings, but it cannot exchange matter.

## (c). An isolated system:

can exchange neither energy nor matter with its surroundings.

## 0-5 The equation of States

### 1). State:

the entire property of a system.

### 2). Function of states:

the property determined by sole value of states.

### 3). Equation of states:

a mathematical relation that interrelates variables of function of states.

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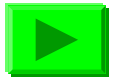
1. The properties of gases 
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