

# Classical Physics

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**Part I**

**Mechanics**

# Chapter 1

## Newtonian mechanics

### 1.1 Laws of motion

1.1 (Galilean structure).

1.2 (Galilean group).

1.3 (Conservation laws).

### 1.2 Oscillation

1.4 (Harmonic oscillator).

1.5 (Damped oscillation).

1.6 (Pendulum).

1.7 (Lissajous curve).

1.8 (Coupled oscillation).

### 1.3 Central forces

1.9 (Polar coordinates).

1.10 (Effective potential).

1.11 (Kepler's problem).

1.12 (Rutherford scattering).

### 1.4 System of particles

1.13 (Closed systems).

1.14 (Collisions).

1.15 (Two-body problem).

1.16 (Three-body problem).

## Exercises

method of similarity (scaling)

## Chapter 2

# Lagrangian mechanics

### 2.1 Calculus of variations

2.1 (Euler-Lagrange equation).

2.2 (Closed system).  $\frac{\partial \mathcal{L}}{\partial t} = 0$

2.3 (Definition of generalized momentum).  $\frac{\partial \mathcal{L}}{\partial q} = 0$

2.4 (Equivalence to Newtonian mechanics).

### 2.2 Rigid bodies

2.5 (Inertia tensor).

2.6 (Eulerian angle).

2.7 (Lagrangian top).

### Exercises

2.8 (Brachistochrone).

2.9 (Geodesic on the sphere).

2.10 (Dido's isoperimetric problem).

2.11 (Pendulum with moving support). A rheonomic system

2.12 (Sliding beads on a rim).

2.13 (Double pulley system).

## **Chapter 3**

# **Hamiltonian mechanics**

### **Exercises**

## Part II



## **Chapter 4**

# **Fluid mechanics**

## **Chapter 5**

# **Waves**

## Chapter 6

# Thermodynamics

### 6.1 Equilibrium

Equation of states Maxwell's relations Thermal processes

### 6.2 Ensembles

ensembles microcanonical, canonical, grand canonical classical gas

## Chapter 7

# Kinetic theory

ergodic hypothesis Boltzmann statistics Boltzmann equation BBGKY hierarchy stochastic processes linear response

## Chapter 8

## Chapter 9

## **Part III**

# **Classical field theory**

## **Chapter 10**

# **Relativity**

**10.1 Special relativity**

**10.2 General relativity**

**10.3 Einstein field equation**

**10.4 Black holes**



## **Chapter 11**

# **Electromagnetism**

## **Chapter 12**

# **Lagrangian field theory**