

SCIENCE

An Introduction to Atomic and Nuclear Physics

I. THE ATOM AND THE QUANTUM 30%

- A. Classical Models of the Atom
 - 1. Atoms in Ancient Philosophy
 - 2. Dalton's Atomic Theory
 - 3. Thomson's "Plum Pudding" Model
 - 4. Rutherford's Planetary Model

- B. Early Quantum Theory and the Bohr Model
 - 1. The Wave Theory of Light
 - 2. Energy Quantization
 - a. Photons
 - b. Atomic spectra and the Rydberg formula
 - 3. The Bohr Model of Hydrogen
 - a. Energy levels

- C. The de Broglie Hypothesis

- D. Wave-Particle Duality

- E. Modern Quantum Mechanics
 - 1. Wave Functions and the Schrödinger Equation
 - 2. Quantum Mechanics and Probability
 - 3. The Heisenberg Uncertainty Principle
 - 4. The Modern Quantum Model
 - a. Orbitals
 - b. Spin
 - 5. The Pauli Exclusion Principle

- F. Applications of Atomic Physics
 - 1. Lasers
 - 2. Laser Cooling
 - 3. Atomic Clocks

II. THE ATOMIC NUCLEUS AND RADIOACTIVITY 30%

- A. Structure of the Nucleus
 - 1. Properties of Atomic Nuclei
 - 2. Discovery of the Proton and Neutron
 - 3. Isotopes

4. Nuclear Force and Binding Energy
5. Nuclear Stability
6. Magnetic Properties of the Nucleus

B. Radioactivity

1. Discovery of Radioactivity
2. Alpha Decay
3. Beta Decay
4. Gamma Decay
5. Induced Radioactivity
6. The Mathematics and Detection of Radioactive Decay
 - a. Exponential decay
 - b. Decay rate and half-life
7. Radioactivity and Quantum Mechanics
8. Decay Chains
9. Detection of Radioactivity

C. Sources and Effects of Radiation

1. Ionizing vs. Non-ionizing Radiation
2. Radiation Dosage
3. Sources of Radiation
4. Health Effects of Radiation

D. Applications of Radioactivity

1. Radiation Therapy and Sterilization
2. Radiometric Dating
3. Smoke Detectors
4. Radioactive Tracers

III. NUCLEAR FISSION AND FUSION

25%

A. Nuclear Reactions

1. Q Values

B. Nuclear Fission

1. Discovery of Fission
2. Chain Reactions
3. Nuclear Reactors
4. Power Plant Operation
5. Breeder Reactors
6. Challenges of Nuclear Power
7. Nuclear Power Plant Accidents
8. Nuclear Weapons

C. Nuclear Fusion

1. Thermonuclear Fusion
2. Stellar Fusion

3. Fusion Weapons
4. Fusion Reactors

IV. THE MANHATTAN PROJECT AND THE ATOMIC BOMB

15%

A. Origins of the Project

1. The Einstein-Szilárd Letter
2. Pilot Research

B. Moving Toward Production

1. The Manhattan Project
2. Groves and Oppenheimer
3. Oak Ridge
4. Hanford Engineer Works
5. Los Alamos

C. Development of the Bomb

1. Detonation Mechanism
2. Trinity Test

D. Using the Bombs

1. President Truman
2. Proposed Demonstration and Selection of Targets
3. Hiroshima and Nagasaki
4. End of the War

E. Postwar Events and Legacy

1. The Atomic Energy Commission
2. The Atomic Age
3. The Cold War and the Arms Race
4. Atoms for Peace