

Review 1

1 hour exam covering the first three chapters. Please arrive 5 min early. ID will be checked when the exam is turned in. A single page “cheat” sheet is allowed, but it can only contain equations and constants. It will be randomly checked.

Five multiple choice questions, 5 points each; four simple questions, 8 points each; three more complex questions, 12-15 points each.

1. Classical physics

Classical physics: What are the differences between particles and waves? What are the appropriate equations? Trajectories, forces and potentials, kinetic energy and potential energy. Conversion between frequency, wavelength, and wavenumber. Conversion between energy units.

2. Failure of classical physics

Blackbody radiation: definition of blackbody, Rayleigh-Jeans law and its classical assumption, ultraviolet catastrophe. Planck's distribution and its assumption, its behavior at short and long wavelengths, its relationship to Rayleigh-Jeans law. Quantization of oscillator energy, Planck's constant.

Photoelectric effect: physical setup of the experiment, Einstein's theory, threshold frequency and work function, quantization of radiation field, photons.

Matter wave: de Broglie's thesis, wave-particle duality, experimental proof via electron diffraction.

Atomic spectra: problems with classical atomic models, Rydberg's formula, Bohr's model, quantization of atomic energy levels.

3. Quantum mechanics

Quantum mechanical postulates, Schrödinger equation, observables and operators, position and momentum operators, Hamiltonian operator, kinetic and potential energy operators, eigenequation, eigenvalues and eigenfunctions of Hermitian operators, orthonormality, degeneracy, measurement, expectation values and superposition principle.

Born's interpretation of wavefunction, wavefunction as probability amplitude, squared wavefunction gives probability density, probability and normalization, general properties of wavefunction.