

## Review 3

1 hour exam.

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.

Five multiple choice questions, 5 points each, only one answer.

Four simple questions, 8-10 points each.

Two more complex questions, 15-20 points each.

### 1. Vibrational and rotational spectra

Spontaneous emission, stimulated absorption and emission, concept of Raman spectra, Einstein coefficients and transition dipole, Boltzmann distribution, population of states.

Moment of inertia, spherical and linear rotors, energy expressions, rotational terms, and quantum numbers, rotational constants, selection rules, microwave spectra, determination of bond length from microwave spectra.

Harmonic oscillator, frequency and force constant, Morse potential and anharmonicity, vibrational energy and term, selection rules, vibrational spectra, ro-vibrational term and spectra, P, Q, R branches,  $(3N-6)$  normal modes.

### 2. Atomic structure

Hydrogenic atoms, Hamiltonian, separation of variables, angular and radial equations, the solution of Schrodinger equation, energy and Rydberg's formula, quantum numbers, wavefunctions and orbitals, shells and subshells, s orbitals and radial distribution function, p orbitals and linear combinations, minima, maxima, and nodes, selection rules.

Multielectron atoms, Hamiltonian, Hartree approximation, Fermions and Bosons, spin angular momentum and quantum numbers, Pauli principle and exchange operator, Hartree-Fock approximation and SCF, aufbau principle, penetration and shielding, double occupancy rule, Hund's rule, term symbols, angular momentum coupling and Clebsch-Gordan series, spin multiplicity, spin-orbit coupling and fine structure, selection rules.