Physics 262 Fall 2006: Review of topics

Part I: Optics

- E & M Waves
  - Faraday’s Law (flux, emf, Lenz’ Law, magnetic energy)
  - Maxwell-Ampere Law (displacement current)
  - EM wave equation ($\vec{E} \perp \vec{B} \perp \hat{k}$, Maxwell’s equations)
  - EM wave energy & momentum (Poynting, $P_{\text{rad}}$, intensity)
  - Polarization (Brewster angle, Malus’ Law)

- Geometric Optics
  - Reflection & Refraction (Snell’s Law, total internal reflection)
  - Images (real, virtual, multiple)
  - Spherical mirrors (imaging equation, lateral magnification)
  - Spherical refractors (imaging equation, lateral magnification)
  - Thin lenses (imaging equation, Lensmaker’s equation)
  - Sign Rules!!!

- Wave Optics
  - Chromatic dispersion
  - Interference basics (constructive, destructive)
  - Reflection, transmission coefficients (intensity, amplitude)
  - Phase change physics (distance, $n$, hard reflection)
  - Phasor math
  - Thin films
  - Young’s slits (1, 2, $n$ slits)
  - Michelson interferometer
  - Coherence length/time (transverse, longitudinal)
  - Resolvability, diffraction limit (James Bond stuff)
Part II: Relativity

• Coordinates
  – Events, reference frames (IRFs, NIRFs)
  – Principles of Relativity, Equivalence

• Geometry
  – Galilean/Lorentz invariants (spacetime interval)
  – Spacetime diagrams (axes, scales, worldlines)
  – Euclidean/Minkowski 4-vectors (dot product)
  – Galilean/Lorentz transformations (inverses too)
  – Timelike, spacelike, lightlike (Principle of Causality, light cone)
  – Relativity of Simultaneity (time dilation, length contraction, proper time)

• Kinematics
  – Doppler effect (longitudinal, transverse, redshift)
  – Velocity transformation (Galilean, Lorentzian)
  – Twin paradox
  – 4-velocity

• Dynamics
  – Einstein postulates
  – Newton’s laws in special relativity \((p = \gamma mv)\)
  – Energy, momentum kinetic energy \((E^2 = p^2c^2 + m^2c^4)\)
  – 4-momentum (length, transformation)
Part III: Quantum Mechanics

- Light-matter interactions (Old Quantum Theory)
  - Blackbody Radiation (Planck, Wien, Rayleigh-Jeans, Stefan-Boltzmann)
  - Photoelectric effect
  - Bremsstrahlung
  - Thermionic emission
  - Moseley’s Law
  - Compton effect
  - Quantum hypotheses (Planck, Einstein, Bohr, de Broglie)

- Atomic structure (Old Quantum Theory)
  - Line spectra (Balmer, etc. formulas)
  - Thomson vs. Rutherford atom
  - Bohr model (Derivation, $E_n$, $r_n$, reduced mass, line spectra)

- Probabilistic/wave nature of light & matter (Quantum Mechanics)
  - Single photon, $e^-$ diffraction
  - de Broglie wavelength
  - Heisenberg uncertainty relations ($\Delta E \Delta t$, $\Delta x \Delta p$)
  - Born interpretation ($\langle f(x) \rangle$, $\int |\psi|^2 = 1$)
  - Schrödinger equation ($\mathbb{C}$, time independent, dependent versions)
  - Solving Schrödinger’s equation (Boundary conditions)
  - Potential wells and barriers (infinite well $\psi_n$, $E_n$; tunneling)