Physics 206 – Spring 2019
Unit Q Exam Study Guide

- Failures of classical theories/experiments that led to quantum mechanics
  1. The photoelectric effect
  2. blackbody radiation and the ultraviolet catastrophe (Raleigh-Jeans law), and its resolution
  3. The Davisson-Germer experiment (electron diffraction)
- Atomic models
  1. The Rutherford model
  2. The Bohr model and discrete orbits
- The wave-particle duality and its interpretation (quantum particles)
- The deBröglie wavelength
- The Compton wavelength
- Hilbert space
- Discrete states: eigenvectors and eigenvalues
- Wavefunctions: eigenfunctions and eigenvalues
- Superposition states, probability amplitudes, and measurement; collapse of the state vector / wavefunction
- Dirac notation
- Unitarity
  1. Discrete: $|\psi\rangle = \sum_{i=1}^{n} a_i |i\rangle \implies \langle\psi|\psi\rangle = \sum_{i=1}^{n} |a_i|^2 = 1$
  2. Continuous: $\int_{-\infty}^{\infty} |\psi(x)|^2 \, dx = 1$
- Unitary quantum evolution operators: $|\phi\rangle = \hat{U}|\psi\rangle \implies \langle\phi|\phi\rangle = \langle\psi|\psi\rangle$
- Hermitian operators / observables and real eigenvalues: $\hat{M}|\psi\rangle = m|\psi\rangle$
- Position expectation value (average position): $\langle\hat{X}\rangle = \int_{-\infty}^{\infty} x|\psi(x)|^2 \, dx$
- Heisenberg uncertainty principle (p, x and E, t versions)

- The Schrödinger equation (time independent and dependent)
- Solutions to the Schrödinger equation
    1. Free particle
    2. Particle in a box (infinite potential well)
    3. Quantum harmonic oscillator
- Quantum tunneling