Skills and Techniques. You should be able to:

1. Write down the coordinates \((ct, x)\) of an event from its description and use the Lorentz Transformation to find the coordinates in another frame.

2. Use and apply (where appropriate!) the ideas of time dilation and Lorentz contraction.

3. Analyze simple collisions or particle decays involving the conversion of rest energy into (or out of) kinetic energy or binding energy. Transform quantities between lab frame and center of momentum frame.

4. Describe the photoelectric effect and explain why it implies discrete photon energies.

5. Calculate the energy transferred in Compton scattering.

6. Derive the Bohr model results from Coulomb force law: discrete radii, energies.

7. Use the Uncertainty Principle for simple estimates (smallest energy in a box, width of spectral lines, range of strong force)

8. Calculate the deBroglie wavelength of a particle and discuss its meaning.

9. Discuss the interpretation of wave functions; compute expectation values, probability distributions, energy eigenstates.

10. Sketch an energy-level diagram for hydrogen and indicate various series transitions.

11. Sketch wave functions for any one-dimensional potential

12. Solve the 1D time-independent Schrödinger equation for an infinite square well

13. Explain the origin of quantization of angular momentum and energy

14. Explain spin-orbit effect and how this modifies energy levels

15. Know how to combine angular-momentum quantum numbers

16. Find and/or use \(N(\leq E), n(E), g(E)\) given the properties of a simple quantum system, compute the Fermi Energy of a distribution of fermions

17. explain the differences between collections of fermions and collections of bosons

18. find the Q value of a nuclear reaction or the binding energy of a nucleus

19. describe the four fundamental interactions and their mediating particles; use a Feynman diagram to illustrate the role of the mediating particle.

20. identify reactions that violate/observe conservation laws involving quantum numbers