Question 1

How does Bohr’s principal quantum number $n$ arise from the quantum mechanical solution of the Coulomb potential? How does it arise in the Bohr model? What explains that these two (conceptually) very different $n$ numbers coincide?

For a given $l$, $n$ is the highest degree in the corresponding series solution if $l = 0$ or it is related to it by a shift of $l$ when $l \neq 0$. The spectroscopic Bohr principal number $n$ just labels the levels counting from the bottom independent of $l$. The accidental symmetry of the Coulomb problem under $O(4)$, the rotation group in 4D, is responsible for this coincidence (The first level for $l = 1$ coincides with the second level for $l = 0$, etc.)

Question 2

How many different angular momentum operators appear in section 12.5? What is the complete set of commuting observables (CSCO) that helps solve the Coulomb problem?

Three: $L$, $J_1$ and $J_2$ ($K$ and $A$ are not angular momenta). The CSCO is $\{H, J_1, J_2\}$.

Question 3

What rules do you plan to memorize to determine the shape of the hydrogen wave functions on pages 272-273?

All functions vanish at $r = 0$ except $l = 0$ states which are finite at $r = 0$. All functions vanish exponentially at $r = \infty$. The number of axis crossings (nodes) equals $n - l - 1$. The height of successive extrema decrease with $r$.

Question X

Is the Runge-Lenz vector $K$ a quantum mechanical vector operator and does it commute with the angular momentum $L$?

Yes, $K$ is a vector operator. No, it does not commute with $L$.

Question Y

Plot the radial bound-state energy eigenfunction $R_{52}$. 