Before-class Questions #8:

Question 1: What does the polarizability of a hydrogen atom have in common with a metallic conducting sphere? Do larger atoms have larger polarizabilities?
Answer: They both have a polarizability that scales with their volume. Correspondingly, larger atoms will have larger polarizabilities.

Question 2: Why is there a break down of perturbation theory at very small electric fields for electronically excited states but not the ground state?
Answer: Degeneracies found in the excited states can have opposite parities, allowing the dipole matrix element to couple states that are very close in energy.

Question 3: How does the critical electric field, where perturbation theory breaks down, scale with electronic number "n"? What does this mean for Rydberg atoms?
Answer: The critical field scales as n^(-5), implying that perturbation theory for Rydberg atoms quickly becomes invalid with any significant applied field. Instead, strong level mixing occurs.

Question 4: What is typically the method of choice for detecting Rydberg atoms, and why?
Answer: State-selective field ionization, due to the n^(-4) scaling of field required to ionize atoms.

Question 5: There is a time-independent and time-dependent way for obtaining the AC Stark shift. The time-dependent method uses an oscillating electric field in a coherent state.
What does the time-independent method do differently?
Answer: The time-independent approach uses photon Fock states to remove all time dependence, essentially redefining the energy levels as the entire atom+field system rather than just the atom.

Question 6: Which quantity is directly proportional to the index of refraction? What effect do the real and imaginary part of index of refraction have on light passing through the medium?
Answer: Polarizability. Real part: absorption. Imaginary part: phase shift, dispersion.