

Physics 125c  
Problem set number 10  
Due Wednesday, June 9, 2004

**Notes about course:**

- There is a web page for this course, which should be referred to for the most up-to-date information. The URL:  
<http://www.hep.caltech.edu/~fcp/ph125/>
- This is the last homework assignment for underclass students. It has been suggested, belatedly, that we not actually have a tenth assignment, for consistency with the seniors and graduate students. We'll discuss this in the last class, on June 2, and decide then.

**PROBLEMS:**

36. Proof of the von Neumann mixing theorem: Do exercise 4 of the “Density Matrix Formalism” course note.
37. Do exercise 7 of the “Density Matrix Formalism” course note.
38. Electric dipole selection rules: In problem 28 we investigated the life time of a hydrogen level under the long wavelength “electric dipole” approximation. It is conceivable the the result of such a computation could be zero, in some cases, that is, the transition is forbidden in this approximation (but perhaps allowed in higher orders in the expansion of the  $e^{i\mathbf{k}\cdot\mathbf{x}}$  expansion). Consider transitions between states of specified initial and final orbital angular momentum,  $\ell_i$  and  $\ell_f$ , and initial and final projections of the orbital angular momentum on the  $z$ -axis,  $m_i$  and  $m_f$ . In the electric dipole approximation, what transitions are permitted (e.g., what are the permitted values of  $\ell_f$  and  $m_f$  if  $\ell_i$  and  $m_i$  are given)?