PHY-852 QUANTUM MECHANICS II
Homework 3, 30 points
January 30 - February 6, 2002
Orbital momentum. Central field.
Reading: *Merzbacher*, Chapter 11, sections 3 - 5; Chapter 12.

1. *a.* /5/ Show that an arbitrary angular wave function of a particle with orbital momentum $l = 1$ can be written as

$$\psi(\mathbf{n}) = (\mathbf{a} \cdot \mathbf{n}), \tag{1}$$

where $\mathbf{a}$ is some *complex* vector independent on the direction of $\mathbf{n} = \mathbf{r}/r$.

b. /3/ Let $|\psi\rangle$ be a state of a particle with orbital momentum $l = 1$, and $\mathbf{e}$ a unit vector in some direction. Find the result of action

$$\left[(\hat{\mathbf{l}} \cdot \mathbf{e})^2 - 1\right](\hat{\mathbf{l}} \cdot \mathbf{e})|\psi\rangle. \tag{2}$$

c. /4/ For the state (1) find the expectation values of the orbital momentum components $\hat{l}_k$.

2. *a.* /6/ *Merzbacher*, Problem 7, p. 276.

b. /6/ *Merzbacher*, Problem 8, p. 276.

3. /6/ *Merzbacher*, Problem 14, p. 276.