AQM - EX 1 - 30/10/2011

1) CONSIDER THE WAVE FUNCTION

$$\psi(0,x) = N\sqrt{1-x^2}\,\vartheta(1-x^2)$$

a) Determine N

b) Determine the probability to find the particle between $-\frac{1}{2} < x < \frac{1}{2}$ by a measurement of the position.

c) Determine $\langle x \rangle$, $\langle x^2 \rangle$, Δx

d) Determine $\langle p \rangle$, $\langle p^2 \rangle$, Δp. Check if $\Delta x \Delta p$ fulfills Heisenberg uncertainty relation

2) CONSIDER AN e^- IN A H-atom WITH THE FOLLOWING WAVE FUNCTION:

$$|\psi\rangle = \alpha|1,0,0\rangle + \beta|2,0,0\rangle + \gamma(|2,1,-1\rangle + |2,1,1\rangle + |2,1$$

WHERE THE USUAL $|n,\ell,m\rangle$ NOTATION IS USED.

a) which condition do α, β, γ fulfill?

b) which conditions shall α, β, γ fulfill in order that $|\psi\rangle$ is an eigenvector of the hamiltonian generale?

c) which conditions shall α, β, γ fulfill in order that $|\psi\rangle$ is an eigenvector of $\vec{L}^2$?

d) which conditions shall α, β, γ fulfill in order that $|\psi\rangle$ is an eigenvector of L_z?

Determine for b, c, d the corresponding eigenvalues

e) Determine the constants α, β, γ under the assumptions that (i) they are real (ii) $|\psi\rangle$ is an eigenvector of H (iii) the prob. to find $2\hbar^2$ by a measurement of $\vec{L}^2$ is equal to 50%.

3) DETERMINE THE EIGENVALUES OF THE POTENTIAL

$$V(x) = \begin{cases} \frac{1}{2} m \omega^2 x^2 & x \geq 0 \\ \infty & x < 0 \end{cases}$$

NO CALCULATIONS ARE NEEDED
(USE THE RESULTS OF THE STANDARD H.O. AND "EXTRAPOLATE").