Physics 829 Spring 2000
Dr. Herbst

MIDTERM EXAMINATION (In Class; Closed Book)
12 MAY
(100 POINTS)

1) (20 points) A one-dimensional harmonic oscillator is subjected to a perturbation of the type ax^3. Use stationary perturbation theory through second order to determine the correction to the ground state energy.

$$E_n = \hbar\omega(n + 1/2); \quad (x)_{n,\, n+1} = \{\frac{\hbar(n+1)}{2\mu\omega}\}^{1/2}$$

2) (40 points) Find the best value for the ground state energy for a particle of mass m in the gravitational potential:

$$V = gz;\ z \geq 0; \quad V = \infty;\ z < 0$$

with the variational trial function $z\exp(-az)$. Then compare your answer with that obtained from the WKB approach.

3) (40 points)

a) (12 pts) A hydrogen atom in its 1s state is placed in a static electric field directed along the z-axis for a time τ. Use time-dependent perturbation theory (first order) to determine the probability of transition to the $2p_0$ level as a function of τ. $\langle 2p_0|ez|1s\rangle = 0.74ea_0$. $E_n = -e^2/2a_0n^2$

b) (12 pts) How does your answer to a) change if instead of a static field, monochromatic radiation of resonant frequency ω is used?

c) (16 pts) How does your answer to b) change if instead of monochromatic radiation, a range of frequencies centered on the resonant frequency is used?

Do not use the infinite time limit. For part (c), assume a flat distribution function g(ω)dωand integrate over all frequencies.