Quantum Mechanics, Spring 2004

Homework #6, Due 25/3/2004

1. Sakurai Chapter 4, problem 5 (page 282)

2. (a) Consider a symmetric double well potential as an infinite well of width $2w$ perturbed by a barrier of width $2a$ and height h. Calculate (to the first order) the energies and wavefunctions of the lowest two energy eigenstates.

(b) Given that the frequency of oscillations between the two states of ammonia molecule (see sakurai page 259) is 24,000 MHz, estimate the height of the potential barrier in eV. Assume $w = 2a \sim 1A^\circ$ for estimation purposes.

3. Consider a periodic attractive delta function potential

$$V = -V_0 \sum_{n=-\infty}^{\infty} \delta(x + na)$$

(a) Determine the condition a bound state needs to satisfy. From that, find a lower bound on the ground state energy. (Bloch's theorem may be assumed.)

(b) Determine the allowed energy levels for scattering states.

4. Sakurai Chapter 4, problem 11 (page 284)

5. Show that the electric dipole moment of an electron violates parity as well as time reversal symmetry.

6. Consider a linearly perturbed 1-d harmonic oscillator potential:

$$H = \frac{p^2}{2m} + \frac{1}{2}kx^2 + kax$$

(a) Calculate the new energy levels to second order in perturbation theory. Compare with the exact solution.

(b) Calculate the new eigenfunctions to first order in perturbation theory.