Problem Set 6
Phy 211 - Fall 2002
Assigned: Friday, Oct. 17; Due: Thursday Oct. 24
DUE AT THE BEGINNING OF CLASS

Problem 1: Time Evolution and Parity

Prove that if $[\Pi, H] = 0$ ($\Pi$ is the parity operator, $H$ is the Hamiltonian) then a state
with even or odd parity maintains its parity for all time. For a state with indefinite parity,
show that the expectation value $\langle \Pi \rangle$ is constant in time.

Problem 2: $X, P$ Expectation Values in Simple Harmonic Oscillator Eigenstates

Shankar, Problem 7.4.2

Problem 3: Virial Theorem for Simple Harmonic Oscillator

Shankar, Problem 7.4.3

Problem 4: Time Evolution and the Simple Harmonic Oscillator

Shankar, Problem 7.4.5

Problem 5: Coherent States (Graduate Student Problem)

Coherent states are eigenstates of the lowering operator

$$\hat{a}|z\rangle = z|z\rangle$$

where $z$ is a complex number.

First do Shankar,7.4.6. Then use this result calculate $\langle x(t) \rangle$ and $\langle p(t) \rangle$ for a coherent
state. Note that, unlike the energy eigenstates, these expectation values evolve like $x(t)$ and
$p(t)$ of a classical particle.