Quantum Mechanics
September, 7 2017, I part

PROBLEM A

A system is described by the following Hamiltonian:

$$H = \hbar\omega \begin{pmatrix} 2 & -3i \\ 3i & -2 \end{pmatrix} \tag{1}$$

Let us consider the following observables:

$$O_1 = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \tag{2}$$

and

$$O_2 = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} \tag{3}$$

At the time $t = 0$ a measure of O_1 gives as a results its minimal eigenvalue. Find the probability that a measure of O_1 at the generic time t gives the same result in the three cases:

1. In the time interval $[0, t]$ no measure has been performed on the system.
2. At the time $t_1 \in [0, t]$ we measure O_2 and as a result we get the maximal eigenvalue of O_2.
3. At the time $t_1 \in [0, t]$ we measure O_2.

PROBLEM B

Two particles with spin $s_1 = 1$ and $s_2 = 2$ are at rest in a configuration with total spin 3 and total spin projection $S_z = -\hbar$. Which results can we obtain by measuring s_2^z ? What are the probabilities associated with such measures?

PROBLEM C

An 1–d harmonic oscillator with frequency ω and mass m is perturbed by the potential

$$\hat{V} = \epsilon \hat{p}^2$$

Determine the energy shift for all eigenvalues to first order in ϵ.