

Note: For this and all future assignments, place this problem sheet as the cover page (first page) of your homework, followed by your numbered solutions.

Your Name _____

Phys. 606 **Homework 1** (due 9/5)

Problem 1 (3.2 of Baym)

- (a) Write out $\delta(\mathbf{r}-\mathbf{r}')$ as the product of three one-dimensional delta functions in spherical coordinates.
- (b) What is the Fourier transform of $\delta(\mathbf{r}-\mathbf{r}')$? Write out $\delta(\mathbf{r}-\mathbf{r}')$ in terms of its Fourier transform.
- (c) Show that $\langle \mathbf{p}|\mathbf{p}' \rangle = (2\pi\hbar)^3 \delta(\mathbf{p}-\mathbf{p}')$.

Problem 2 (3.3 of Baym)

What is the representation of the position operator in the momentum basis, ie., how is $\langle \mathbf{p}|\mathbf{r}_{op}|\Psi \rangle$ related to $\langle \mathbf{p}|\Psi \rangle$?

Problem 3 (3.4 of Baym)

Suppose that the potential is $V(\mathbf{r}) = (k/2)r^2$. What is the Schrodinger equation written in momentum space; that is, what is the equation of motion for the amplitude $\langle \mathbf{p}|\Psi(t) \rangle$?

Problem 4 (3.5 of Baym)

What is $[y_{op}, (p_x)_{op}]$? Compare these commutation relations for position and momentum with the classical Poisson bracket relations satisfied by \mathbf{p} and \mathbf{r} .

Problem 5 (3.6 of Baym)

What is the expectation value of the kinetic energy of a particle in terms of its wave function?