Your Name _____

Phys606 **Homework 3** (due 9/19)

Problem 1 a) Show that the angular momentum operator below is Hermitian.

$$\mathbf{L} = \mathbf{r} \times \mathbf{p}$$

b) Is the following operator Hermitian?

$$\mathbf{p} \times \mathbf{L}.$$

Problem 2 (4.1 of Baym)
Why are there no solutions for $E < 0$ for the barrier problem,

$$V(X) = \begin{cases} 0, & X<0 \\ \\ V>0, & X>0 \end{cases}$$

Problem 3 Consider the wave function

$$\psi(x) = [Ae^{ipx/\hbar} + Be^{-ipx/\hbar}]e^{-ip^2t/2m\hbar}.$$

Calculate the probability current associated with this wave function.

Problem 4: (4.3a of Baym) Calculate for both $E < V$ and $E > V$ the transmission and reflection amplitudes for the potential barrier

$$V(X) = \begin{cases} 0, \text{ for } X<0 \text{ or } X>a \\ \\ V, \text{ for } 0<X<a \end{cases}$$

where $V > 0$. You can use the master formula given in class.

Problem 5. For the finite well problem considered in class, the bound state wave functions inside the well are given by coefficients C and D for $A = 0$ and $G = 0$. By solving for C and D in terms of B, show that for

$$\tan\left(\frac{k'a}{2}\right) = \frac{\alpha}{k'}$$

the wave function is even about $x = a/2$ given by

$$\psi_{II}(x) = B\frac{\cos[k'(x - a/2)]}{\cos(k'a/2)}.$$

Bonus 10 pts: Find also the odd wave functions corresponding to

$$\cot\left(\frac{k'a}{2}\right) = -\frac{\alpha}{k'}.$$