

FINAL EXAM

**Physics 751**  
**Advanced Solid State Physics**  
**Fall, 2001**

1. Suppose that fermions in two dimensions interact by a potential  $U(q) = U$  if  $q < q_0$ , and  $U = 0$  otherwise. Find the scattering amplitude for two particles with momentum  $k$  and  $-k$  ( $k \ll q_0$ ).
2. Derive diagrammatically the expression for the Hartree-Fock potential in an electron gas.
3. Estimate  $m^*/m - 1$  in a weakly-nonideal gas with a constant interaction  $U$  (how it scales with  $U$ ).
4. Consider a gas of fermions with  $S = 1/2$  but no charge. Estimate the value of a magnetic field that destroys  $s$ -wave superconductivity.
5. Suppose that particles at the Fermi surface attract each other by a potential  $U(p, p') = U_{\mathbf{p}\mathbf{p}'}$ . Obtain the expression for a superconducting gap. What is the total spin of a pair. [Assume that the interaction is zero above some energy cutoff  $\Lambda$ ].