PHYS421	Name:	*Mark* :	*Initials*: VF

Lancaster University Department of Physics

PHYS421 - Adv Solid State (magnetism) and Nanoscale Physics

Michaelmas Term 2006
Sheet 6 (total mark = 20)

1. [5] Following lecture notes, derive the Drude formula for the conductivity of two-dimensional electrons. Then, use the relations between the electron density, Fermi velocity, density of states γ_F and the mass of two-dimensional electrons to show that the Drude formula is equivalent to the Einstein relation $\sigma = e^2\gamma_F D$ between the conductivity, σ and diffusion coefficient, D.

2. [6] Describe the phenomenon of the enhanced back-scattering of waves from disordered media. Explain how does the enhanced back-scattering of electrons in phase-coherent conductors lead to the weak localisation effect?

3. [5] Explain (qualitatively) the origin of the weak-localisation magneto-resistance effect in a two-dimensional electron gas in semiconductor heterostructures.

4. Open-ended assignment [4]. The attached graph contains the magnetic field dependence of conductance of a mesoscopic metallic ring measured at a very low temperature. Interpret the origin of the observed magneto-oscillations (in terms of the Aharonov-Bohm effect) and determine the size of the ring used in the experiment from the data shown in the graph.

THIS SHEET MUST BE ATTACHED TO YOUR ANSWERS. Inserting your name in the appropriate place at the top of this page. Please ensure your work is clearly legible. Do not submit your work in folders or plastic sleeves. Your answers should be placed in the appropriate in-box in the Physics Foyer not later than 16:00 on Wednesday, 13 December 2006. Work handed in after the above time and before 11 am on the following Monday will be subject to a 50% reduction of mark. Work handed in later than this will not count towards your continuous assessment.

I declare that this submission is my own work. I have not submitted it in substantially the same form towards the award of a degree or other qualification. It has not been written or composed by any other person and all sources have been appropriately referenced or acknowledged.

Signed:

Given a pattern of Aharonov-Bohm oscillations observed in a small conducting ring and

$$\Phi_0 = \frac{hc}{e} = 0.4136 \times 10^{-10} \ \ cm^2 T$$

estimate a radius of the ring used in this experiment.