Student name : *Mark* : *Initials*: VF

Lancaster University Department of Physics

PHYS421 - Michaelmas Term 2010
Sheet 3 (total mark = 30)

THIS SHEET MUST BE ATTACHED TO YOUR ANSWERS — please insert your name at the top of this page and 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 Tuesday 30 November 2010. Work handed in after the above time and before the seminar on Thursday 12pm will be subject to a 10% reduction. 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:

1. **[7]** Use the Ginzburg-Landau approach (taking into account the effect of crystalline anisotropy) to describe magnetisation near a ferromagnetic phase transition in a crystal with cubic symmetry. How many energetically equivalent directions (easy-axes) may exist in such a crystal?

3. [5] Describe lattice structure (Braviais lattice and the unit cell), Brillouin zone, and electronic band structure of graphene.

4. [5] Using internet or science magazines/journals, find an example of either experimental studies or a suggested application of graphene. Write, in your own words, a 2-page report upon the results of your reading (when suitable, including sketches).

5. [5] Following notes, reproduce the derivation of the formula describing conductance of a smooth ('adiabatic') ballistic constriction between two 2D electron gases. How can this formula be generalized in order to include the effect of a scatterer in an imperfect wire?

6. [4] (a) Describe how a high-quality 2D electron gas is formed in GaAs/AlGaAs heterostructures, and how it can be used to manufacture one-dimensional wires.

[4] (b) Estimate conductance of a long ballistic wire (produced using split-gates deposited on the top of GaAs/AlGaAs heterostructure) with the width $L_\perp = 100$nm connecting two 2D reservoirs of electrons with the sheet electron density $n_e = 10^{11}\text{cm}^{-2}$.