

# Exam – FKA091/FIM530 Condensed Matter Physics

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*No material is allowed.*

You must answer in English. There are 8 problems worth a maximum of 25 points.

1. Calculate pressure of the Fermi gas at  $T=0$ . (2p)
2. Compare the Sommerfeld and Bloch descriptions of electron states (3p)
3. Describe the motion of electron in a 1D crystal in a constant electrical field.  
Derive the period and amplitude of the Bloch oscillations. (3p)
4. a) What is the Boltzmann equation? Discuss its structure. (2p)  
b) Derive an expression for the conductivity in the  $\tau$ -approximation (3p)
5. What is Landau quantization? Derive the energy spectrum for free electrons in a magnetic field. (3p)
6. Describe the main properties of the superconducting state. (3p)
7. Discuss the London equation for the supercurrent. Derive the expression for the penetration depth of the magnetic field. (3p)
8. Give two examples of a second order phase transition and describe the corresponding order parameters. (3p)