

# HW6

MTLE-6120: Spring 2018

Due: Mar 12, 2018

## 1. Fermi theory properties of a metal in 2D

Consider a simple metal in 2D containing  $n_{\text{ion}}$  ions per unit area. For all questions asking for a 'dependence' below, only predict the power law eg. explain why something is  $T^3$  (say), without worrying about the prefactor.

- What is the temperature dependence of electronic heat capacity for  $T \ll T_F$ ?
- What is the frequency dependence of the phonon density of states  $g(\omega)$  in the Debye model?
- What is the temperature dependence of the lattice heat capacity for  $T \ll T_D$ ?
- What is the lattice heat capacity per unit area for  $T \gg T_D$ ? (Give absolute expression.)
- What is the temperature dependence of electronic resistivity for  $T \ll T_D$ ?
- What is the temperature dependence of electronic resistivity for  $T \gg T_D$ ?

## 2. Kasap 5.11: Ionization at low temperatures in doped semiconductors

Note that there are effectively three questions in that problem, listed out below for clarity:

- Show equation 5.85 for  $n$ -doping.
- Show that 5.85 reduces to 5.19 at low temperatures.
- Estimate 90% ionization temperature for Ga  $p$ -doping in Si.

## 3. Kasap 5.18: Hall effect in semiconductors

Hint: maybe do part (b) first to get some intuition.

## 4. Kasap 5.20: Compound semiconductor devices