SECRET STUDENT NUMBER: STUDNUMBER

LONG ANSWER SECTION

1. Consider a large two-dimensional array of N coupled harmonic oscillators in area A that lie in the $x-y$ plane when at rest. The oscillator's movement is also confined to the $x-y$ plane. In the absence of the coupling, each oscillator has a fundamental frequency ω_0. After coupling both the longitudinal and transverse sound modes have a speed c_s.

   (a) (10 pts) Solve for the Debye frequency, ω_D, in terms of ω_0, N, A and c_s.

   (b) (10 pts) For $T << \hbar\omega_D$, find the specific heat per unit area,

   $$C \equiv (1/A)d\langle E\rangle/dT.$$

   (c) (5 pts) What is $C(T \to \infty)$?