

## Problem Set 4

### Physics 240B

Due Thursday February 5, 2009

Do A&M 19.2 and the following:

1. Consider a chain of  $3N$  ions of charge  $2Q, -Q, -Q, 2Q, -Q, -Q, \dots$  with spacing  $a$  between positive and negative ions and spacing  $2a$  between pairs of negative ions.
  - a) Numerically calculate the Coulomb energy per unit cell of the chain in the limit  $N \rightarrow \infty$ . (A unit cell contains one positive and two negative ions.)
  - b) If each pair of ions also has a repulsive potential energy  $\frac{A}{r^9}$ , where  $r$  is separation and  $A$  is a constant, find  $a_o$ , the value of  $a$  in equilibrium.
  - c) Find the work done per length in stretching the chain uniformly by a factor of  $1 + \delta$ .
2. Using the Lennard-Jones potential, calculate the ratio of the cohesive energies of argon in the bcc and fcc structures.
3.
  - a) Do you expect the zero-point energy of a noble gas to be more influential on crystallization (or lack thereof) in two dimensions or in three? Why? You may wish to start by comparing some simple lattices, such as square and cubic; but try to identify what important features change with dimension.
  - b) In practice, two-dimensional helium is studied by using helium atoms on a surface such as graphite. Does this change the relevance of zero-point energy from what it would be in a freestanding film? Why or why not?