1. A&M 19.1 (to do together in class; write up our solution, filling in any missing details)
2. A&M 20.2
3. A&M 20.4
4. Consider the following model of the pair potential $V$ as a function of separation $r$ for a covalent or metallic solid as a hard sphere with a square well:

$$V(r) = \begin{cases} 
\infty & r < \sigma \\
-\epsilon & \sigma \leq r < \sigma + w \\
0 & \sigma + w \leq r 
\end{cases} ,$$

where $\sigma$ is the hard-sphere diameter. At zero temperature, this potential will favor the structure with the highest effective coordination number, defined as the average number of near neighbors lying in the spherical shell between $\sigma$ and $\sigma + w$. The authors of the attached comment consider this coordination in ruling out a particular proposed aperiodic structure for elemental aluminum, at least for the given potential model.

For this problem, limit your attention to the diamond, fcc, and bcc phases; you need not consider the icosahedral structure of Narasimhan and Jarić or the large-unit-cell periodic phase of Adam and Rich. For the three simple periodic structures, plot the ground-state energies as a function of $w$ for the range $0 < w/\sigma < 1$. Given the three choices, which phase should be stable at low temperature for each possible $w$?