Homework Set 4.

Problem 1. How many atoms are in the primitive unit cell of graphite?

Problem 2. List all symmetries (i.e., space group elements) of the hexagonal lattice and compare them with the symmetries of the centered rectangular lattice?

Problem 3. Consider a two-dimensional Bravais lattice that is left invariant after rotation by angle θ around the origin. Suppose the lattice to have points at coordinates $(0, 0)$ and $(a, 0)$

(a) By requiring the image of $(a, 0)$ under rotations through $\pm\theta$ to be in the Bravais lattice, find a simple expression that implicitly specifies all possible rotation axes.

(b) Prove that the only allowed axes are twofold, threefold, fourfold, and sixfold. In particular, it is **impossible** for a Bravais lattice to have a fivefold rotation axis (i.e., rotations by angle $n2\pi/5$ are incompatible with translational symmetry).

Problem 4. Sodium transforms from *bcc* to *hcp* lattice at about $T = 23$ K. Assuming that the density remains fixed, and the c/a ratio is ideal, calculate the *hcp* lattice spacing a given that the cubic lattice spacing $a' = 4.23$ Å in the cubic phase. HINT: For the properties of *hcp* (hexagonal close-packed) structures and ideal c/a ratio check pages 51-52 of the textbook.