MATRL 218/CHEM277: Assignment 2

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1. Explain a, n and d glides in 3D crystals using sketches.
2. Cubic cells always have a $\bar{3}$ or 3 in the space group label. What is the $\bar{3}$ symmetry element in a cube?
3. What is the difference between the 6_1 and 6_5 symmetry operations? Distinguish with a sketch. It is helpful to use a low-symmetry motif such as the letter 'R' for your illustration.
4. In addition to normal symmetry operations, Shubnikov has described elements of color symmetry. For example, the mirror m′ would take a black object and reflect it to a white one as shown below. Sketch 2D objects, if you can, with the following symmetries: (i) 4mm (ii) 4′m′m′ (iii) 2m′m′ (iv) 3′. Hint: The last case is "frustrated". What does this say about spins (as in magnetism) at the corners of a triangle?

5. Illustrate the relationship between *fcc* and *ccp* by sketching layers with hexagonal cells.
6. Calculate the efficiency of packing in the diamond structure. Remember that there are 8 atoms in the cell, and that the atom at (0,0,0) touches the atom at (1/4,1/4,1/4).
7. Under extreme cryogenic conditions, a light isotope of helium, ^{3}He, forms crystals with fascinating physical properties. Using the International Crystal Tables, sketch (by hand, with tiles) a particular polymorph of ^{3}He: space group $P6_3/mmc$ (194), with $a = 3.46$ Å, and $c = 5.60$ Å. The helium atom sits at (0, 0, 0) in the unit cell. Is the resulting structure *hcp* (hexagonal close packed)? Verify your answer with VESTA.
8. Use VESTA to draw all the structures whose data have been presented to you (from α-Po to . . .)