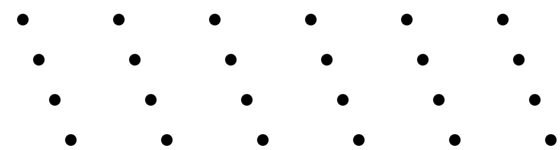
Spring 2008

CHEM 208
Lab 4: Two-Dimensional Plane Groups

In this laboratory you will practice working with two-dimensional repetitive arrays that conform to one of the 17 2-D plane groups (see International Tables Volume A, pp 82-99).

I. Take turns drawing 2-D lattice arrays of dots. For example:



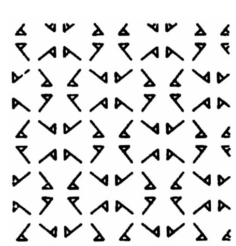
Make at least four different arrays. Sketch a unit cell which represents the smallest possible repeat unit for your array. Remember, this should be a parallelogram. What is the nature of the parameters that describe the unit cell you have chosen? Can you sketch another unit cell that still contains the smallest repeating unit, but is different from the first?

II. Now make arrays of 7's (an asymmetric object) in which the 7's are related only by translation. For example:

7	7	7	7	7	7
7	7	7	7	7	7
7	7	7	7	7	7
7	7	7	7	7	7

Make at least four different arrays. Again, sketch a unit cell which represents the smallest possible repeat unit for your array. How many 7's are in your unit cell? Sketch another unit cell that contains more than the smallest repeat unit. How many 7's are in this unit cell? Identify the symmetry elements present in your arrays. Which 2-D plane groups do your arrays represent?

III. Draw arrays of 7's (or flags) related by rotation and/or reflection. For example:



Try to make some very symmetrical and some less symmetrical arrays. Sketch several possible unit cells for each of your arrays. Identify the symmetry elements present in your arrays. Which 2-D plane group does each of your arrays represent?

IV. The group should pick one array from each set (A-D). In all cases, assume that the array repeats to infinity. For each of these 4 arrays you should answer all of the following questions:

1. On an overhead transparency, sketch a unit cell for the array. Measure the cell parameters (cm and degrees). What is the area of the cell? With a different color or on a different transparency, draw another unit cell that is centered. What are the parameters of this cell (including area)?

2. What are the symmetry elements present in the array? How do each of these elements combine to generate other symmetry elements? Write a group multiplication table for the symmetry elements.

3. What is the name of this plane group?

4. If the coordinates of a point in the unit cell are expressed as x, y (where both x and y range from 0 to 1) find the algebraic form of each of the symmetry elements you found in 2. Show that they combine in the same way that you described in the group multiplication table.

5. Are there any special points within the unit cell for which x,y doesn't change for one of the symmetry operations? How does this connect to the point symmetry?

6. With what point group is your plane group isomorphous? What connection does this symmetry have to the symmetry the diffraction pattern would have?

Your group should prepare one typewritten report for this lab. Only the answers and sketches (on the overhead) from IV should be included.