Homework 6
Due 1 November 2016
The numbers following each question give the approximate percentage of marks allocated to that question.

1. Briefly define/explain each of these terms. Add a sketch if convenient.

   (a) unit cell 5
   (b) lattice parameters 5
   (d) Laue class 5
   (e) symmorphic space group 5
   (f) abelian 5
2. For each group listed below, identify the point group and Bravais lattice.

P6\textsubscript{1}22:
P2\textsubscript{1}/c:
Cmc\textsubscript{2}1:
I4\textsubscript{1}md:
Fd\textsubscript{3}:

3. State the point group that results if a centre of symmetry is added to the following point groups:

(a) 1
(b) 2
(c) 3
(d) 4
(e) 6
(f) 222
(g) 422
(h) 432
(i) 23
(j) 32

4. Calculate the direction which is perpendicular to the normals of both (123) and (4\textbar 0) in a cubic crystal (i.e., the direction contained in both the (123) and (4\textbar 0) planes).
5. Draw schematics showing the positions of objects along a $3_1$ and a $4_3$ screw axis. For each case assume the screw axis is the $c$ axis and draw the axis in two ways, first parallel to the plane ($c$ axis to the right) then perpendicular to the plane ($c$ axis coming out of the plane), using the correct symbol for the symmetry element. Consider the implications of translational symmetry in each case.  

For both $3_1$ and $4_3$, write out the resultant overall transformation (both rotation matrix and translation vector as well as their sum) in an appropriate axis system. 

Demonstrate another way of describing the right-handed $4_3$ screw symmetry?
6. The structure of NaCl is usually described as face-centered cubic in space group \( Fm\overline{3}m \). The ionic positions are:

- \( \text{Na}^+ \quad 4a \quad 0, 0, 0 \)
- \( \text{Cl}^- \quad 4b \quad \frac{1}{2}, \frac{1}{2}, \frac{1}{2} \)

Sketch one unit cell of this structure. How many ions comprise the basis? Annotate your drawing to show these ions.

A body-centered unit cell can be inscribed within the face-centered one. Sketch this new unit cell within a single fcc NaCl one and indicate its basis. What is the new Bravais lattice which is formed?

It is always possible to draw a primitive unit cell of any crystalline structure. Inscribe a primitive unit cell within a single fcc NaCl one and indicate its basis. What is the Bravais lattice now?