**Introduction to Crystallography**

**Midterm Examination 2, November 12, 2008**

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, Student ID.: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

1. I am asking this question as I promised you during the lecture. Please derive the 14 Bravais lattices, step by step starting from the plane lattice types. (It is not necessary to show how multiple cases reduce to the same Bravais lattice. Showing 14 appropriate cases should be enough.) (20 points)
2. For the following point groups, draw in the symmetry elements on a stereogram. Then, using a general pole, show the multiplicity by operating the symmetry elements. Also notify the international symbol of the point group. (20 points)
3. S4
4. C4v
5. Oh
6. D3d
7. Td
8. During the lecture, I systematically derived 17 plane groups considering the glide plane. Since we dealt with plane symmetry, the screw operation was not included. Among these 17 plane space groups, P31m and P3m1 are different in the aspect of the location of the mirror plane relative to the unit cell edge. The mirror plane lies along the edge of the unit cell in the case of P31m while it lies across the edges of the unit cell in the case of P3m1. Draw the following plane groups on a unit cell indicating symmetry elements and multiplied general positions. (20 points)
9. P2gg
10. C2mm
11. P4gm
12. P3m1
13. Draw the symmetry elements of the following space groups in a unit cell. Indentify the multiplicity of the general pole through symmetry operation. Also identify to which crystal system and point group do each of these space group belongs to.(20 points)
14.  (The 2-fold symmetry element lies along the b-axis and you have to draw the projection in the a-c plane.)
15. (Draw the projection in the a-b plane)
16. A force is applied in a general direction resulting in a displacement  with some angle to . These two vectors are related with a second rank tensor $\tilde{K}$. Now, let k1, k2, and k3 be the components of $\tilde{K}$ along the principle axes. Directional cosines of against each principle axis are designated as l, m and n. (20 points)
17. Having K represent the scalar quantity of $\tilde{K}$in a specific direction, express K using the directional cosines against the principle axes.
18. Draw a representation surface of K and note the values of the axial intercepts using k1, k2, and k3.
19. Also identify what the relationship should be between these k1, k2, and k3 values when the crystal structure belongs to the
20. Cubic crystal system
21. Tetragonal crystal system
22. Hexagonal crystal system
23. Orthorhombic crystal system