

UNIVERSITY OF CALIFORNIA
 College of Engineering
 Department of Electrical Engineering
 and Computer Sciences
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Lectures: 237 Cory Hall 10:00-11:00 M,W,F.

EECS 230: Solid State Principles For Applied Sciences and technology
 Problem Set No. 1 : General Symmetry Principles

Problem 1) Molecular (Point) Symmetries

- a) Give the point groups of the following 1) N_2 , 2) anthracene , and 3) SF_5Cl , and 4) cyclopropane.
 b) Give the group operations of each of a)

Problem 2) Basic Symmetry

Consider the symmetry operations of an infinite straight quantum wire oriented along the z-axis and having a square cross-section (x and y axes). a) List the symmetry operations in Schoenflies and international notation.

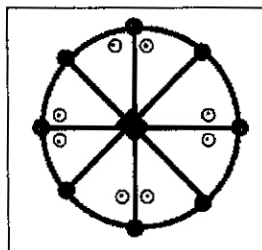
- b) Write the multiplication table with the elements listed horizontally and their respective inverses vertically
 c) Obtain the regular representation
 d) Obtain the characters for the regular representation
 e) Is the regular representation reducible? If so into how many irreducible representations, what orders do they have and how many times does each occur
 f) Obtain the symmetry classes

Problem 3) Symmetry of the Tetrahedron

- a) What are the symmetries associated with a tetrahedron (tetrahedral molecule); a regular octahedron (octahedral bonding). How many "classes" does each have.
 Along with the icosahedron and the dodecahedron these two and the cube constitute the five regular polyhedra.

Problem 4) Representation of Point symmetries with the stereographic projection

- a) For the following stereogram.



give the symmetry operations

- b) Which group does it belong to.
 c) Give a crystal with a lattice having that point symmetry. d) Is that crystal symmorphic or non-symmorphic.
 e) If non-symmorphic state why?

Problem 5) Unit Cells

A primitive unit cell has $a=5.00$, $b=6.00$, $c=7.00 \text{ \AA}$ and $\alpha = \beta = \gamma = 90^\circ$. A new unit cell is chosen with edges defined by the vectors $(3, 1, 0)$; $(1,2,0)$; and $(0,0,1)$.

- a) What is the volume of the original cell?

- b) Calculate the lengths of the three edges and the three angles of the new unit cell.
- c) Calculate the volume of the new unit cell.
- d) How many lattice points does the new cell contain?

Problem 6) Symmetry and Crystal Properties

- a) Consider a crystal with a symmetry axis. The symmetry group contains all the rotations and reflections for the group of the equilateral triangle in a plane perpendicular to the c-axis. In addition it contains a reflection of the crystal through this plane (and its products with the others). What point group does it belong to. Sketch the stereogram.
- b) What are the the nonzero linear electro-optic tensor (matrix) elements for this case.