1. Using the results of problem 3 of Assignment 11:
   (a) Show that $D_4$ is isomorphic with $C_{4v}$ and find geometrical figures for which $D_4$
is the exact group.
   (b) Find classes of $D_4$.
   (c) Decompose products of classes into sums over classes.
   (d) Find the dimensions of irreducible representations.
   (e) From (c) and using character orthogonality relations find the characters of all
irreducible representations of $D_4$.
   (f) Without referring to the characters found in (e), find a 4-dimensional represen-
tation of $D_4$.
   (g) Decompose this representation into irreducible representations.

2. Consider the group SU($n$) of $n \times n$ unitary matrices with unit determinant.
   (a) Express generators of this group in terms of operations on such matrices.
   (b) You should be able to identify objects which can be called “matrix generators”.
       Show that these matrices are traceless and Hermitian.
   (c) How many such matrices exist?

   Hint: Generators are generally defined as

   $$I_\nu = \sum_{i=1}^{n} \left. \frac{\partial f_i(r; a)}{\partial a_\nu} \right|_{a = a_0} \frac{\partial}{\partial x_i} \nu = 1, \ldots, r$$

   where $f$ transforms a vector $r$ into $r'$: $x'_i = f_i(r; a)$, $a_\nu$ are the parameters of
the group, and $a_0$ determines the unity of the group.

3. Exercise 4.2.1 in Arfken-Weber. This exercise involves tedious matrix multiplica-
tions. These are best done using Mathematica.