Exercise 5.1

Consider the following planar symmetric figure.
[A diagram needed]

1. Determine the distinct symmetry operations which take it into itself; construct the group multiplication table for these operations, and identify the point group to which this figure belongs.
2. Find a set of two-dimensional matrices which are in one-to-one correspondence with the above symmetry operations, and verify that they have the same group multiplication table as the symmetry operations.

Solution 5.1

Exercise 5.2

The table below gives the effects of the transformation operator O_R for the symmetry operation R of the point group $\mathscr{D}_4$ on four functions f_1, f_2, f_3, and f_4. Construct a four-dimentional representation of $\mathscr{D}_4$.

$R =$	E	C_4	C_4^3	C_2	C'_{2a}	C'_{2b}	C''_{2a}	C''_{2b}
f_1	f_1	f_2	f_4	f_3	$-f_4$	$-f_2$	$-f_1$	$-f_3$
f_2	f_2	f_3	f_1	f_4	$-f_3$	$-f_1$	$-f_4$	$-f_2$
f_3	f_3	f_4	f_2	f_1	$-f_2$	$-f_4$	$-f_3$	$-f_1$
f_4	f_4	f_1	f_3	f_2	$-f_1$	$-f_3$	$-f_2$	$-f_4$

Solution 5.2

Exercise 5.3

Consider a set of base vectors located on the nuclei of the molecule SO_2 as in the figure below ($\mathbf{e}_3$, $\mathbf{e}_6$, $\mathbf{e}_9$ are perpendicular to the page).
[A diagram needed]
Construct a nine-dimentional matrix representation for the point group to which SO_2 belongs.

Solution 5.3

Exercise 5.4

For the point group $\mathscr{D}_{2h}$:

1. construct a three-dimentional matrix representation using three real p-orbitals as basis functions;
2. construct a five-dimentional matrix representation using five real d-orbitals as basis functions.

Solution 5.4

Exercise 5.5

Consider the planar trivinylmethyl radical with seven π-orbitals located as shown below:
[A diagram needed]
Using these *pi*-orbitals as basis functions, construct a seven-dimensional representation of the $\mathscr{C}_3$ point group.

Solution 5.5