

# Unit 5 - Week 3 - Introduction to Group Multiplication Tables; Stereographic Projections and Matrix Representations of Symmetry Operations

## Course outline

How does an NPTEL online course work?

Week-1: Introduction to Symmetry elements, Symmetry operations and Group Theory

Week 2- Generation of Symmetry Operations from Symmetry Elements; Point Group analysis; Relation between molecular symmetry and physical properties(polarity and chirality).

Week 3 - Introduction to Group Multiplication Tables; Stereographic Projections and Matrix Representations of Symmetry Operations

- Lecture 11
- Lecture 12
- Lecture 13
- Lecture 14
- Lecture 15
- Quiz : Assignment 3
- Feedback form 3
- Solutions of Assignment 3

Week 4- Matrix Representation of Point Group, Introduction to Reducible and Irreducible Representation, Description of Character Table , Great Orthogonality Theorem and its consequences

Week 5 - Constructing Character table using the consequences of GOT, Relation between group theory and quantum mechanics, introduction to Symmetry Adapted Linear Combinations: Projection operator.

Week 6 - Projection operator, concept of Symmetry Adapted Linear Combination(SALC), concept of Linear Combination of Atomic Orbitals(LCAO),LCAO-MO, Hückle Approximations and Introduction to Normal Mode of Vibration.

Week 7 - Molecular Vibrations: Normal modes and their symmetry aspects, Selection rules of fundamental vibrational transitions.

Text Transcripts

Week - 8 - Electronic Transitions

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## Assignment 3

The due date for submitting this assignment has passed. As per our records you have not submitted this assignment.

Due on 2020-02-19, 23:59 IST.

1) What is the matrix representation of  $S_{xy}$ ?

1 point

- $\begin{pmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$
- $\begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$
- $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{pmatrix}$
- $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{pmatrix}$$

2) What is the matrix representation of  $C_2(z)$ ?

1 point

- $\begin{pmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}$
- $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$
- $\begin{pmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$
- $\begin{pmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\begin{pmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

3) For a group;  $X^{-1}AX=B$  and  $Y^{-1}AY=C$ . Then there will be an element Z, for which  $Z^{-1}CZ=B$ . (X, Y, Z, A, B and C belong to same group.)

1 point

- The statement is correct
- The statement is incorrect
- The statement is correct only in some cases
- Information is not sufficient to answer

No, the answer is incorrect.

Score: 0

Accepted Answers:

The statement is correct

4) Consider the  $C_{2v}$  molecule  $SO_2$ . Which one of the following is the correct group multiplication table?

1 point

$C_{2v}$	E	$C_2$	$\sigma_v$	$\sigma'_v$
E	E	$C_2$	$\sigma_v$	$\sigma'_v$
$C_2$	$C_2$	E	$\sigma'_v$	$\sigma_v$
$\sigma_v$	$\sigma_v$	$\sigma'_v$	E	$C_2$
$\sigma'_v$	$\sigma'_v$	$\sigma_v$	$C_2$	E

$C_{2v}$	E	$C_2$	$\sigma_v$	$\sigma'_v$
E	E	$C_2$	$\sigma_v$	$\sigma'_v$
$C_2$	$C_2$	E	$\sigma'_v$	$\sigma_v$
$\sigma_v$	$\sigma_v$	$\sigma'_v$	E	$C_2$
$\sigma'_v$	$\sigma'_v$	$\sigma_v$	$C_2$	E

$C_{2v}$	E	$C_2$	$\sigma_v$	$\sigma'_v$
E	E	$C_2$	$\sigma_v$	$\sigma'_v$
$C_2$	$\sigma'_v$	E	$C_2$	$\sigma_v$
$\sigma_v$	$\sigma_v$	$\sigma'_v$	E	$C_2$
$\sigma'_v$	$\sigma'_v$	$\sigma_v$	$C_2$	E

$C_{2v}$	E	$C_2$	$\sigma_v$	$\sigma'_v$
E	E	$C_2$	$\sigma_v$	$\sigma'_v$
$C_2$	$C_2$	$C_2$	$\sigma'_v$	$\sigma_v$
$\sigma_v$	$\sigma_v$	$\sigma'_v$	E	$C_2$
$\sigma'_v$	$\sigma'_v$	$\sigma_v$	$C_2$	$\sigma_v$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$C_{2v}$	E	$C_2$	$\sigma_v$	$\sigma'_v$
E	E	$C_2$	$\sigma_v$	$\sigma'_v$
$C_2$	$C_2$	E	$\sigma'_v$	$\sigma_v$
$\sigma_v$	$\sigma_v$	$\sigma'_v$	E	$C_2$
$\sigma'_v$	$\sigma'_v$	$\sigma_v$	$C_2$	E

5) What is the matrix representation of the symmetry operation i?

1 point

- $\begin{pmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$
- $\begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{pmatrix}$
- $\begin{pmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{pmatrix}$
- $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\begin{pmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{pmatrix}$$

6) What is the matrix representation of the product  $C_3^2$  i?

1 point

- $\begin{pmatrix} 1/2 & \sqrt{3}/2 & 0 \\ \sqrt{3}/2 & -1/2 & 0 \\ 0 & 0 & -1 \end{pmatrix}$
- $\begin{pmatrix} -1/2 & -\sqrt{3}/2 & 0 \\ \sqrt{3}/2 & 1/2 & 0 \\ 0 & 0 & 1 \end{pmatrix}$
- $\begin{pmatrix} 1/2 & -\sqrt{3}/2 & 0 \\ \sqrt{3}/2 & 1/2 & 0 \\ 0 & 0 & 1 \end{pmatrix}$
- $\begin{pmatrix} 1/2 & \sqrt{3}/2 & 0 \\ -\sqrt{3}/2 & 1/2 & 0 \\ 0 & 0 & -1 \end{pmatrix}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\begin{pmatrix} 1/2 & \sqrt{3}/2 & 0 \\ -\sqrt{3}/2 & 1/2 & 0 \\ 0 & 0 & -1 \end{pmatrix}$$

7) Consider  $CO_3^{2-}$  molecule. What is the point group and equivalent operation for the product  $C_2(x) C_3^2(z) \sigma_v(xz)$  ?(take the molecular plane to be XY plane)

1 point

- $D_{3h}; C_3^2(z)$
- $D_{3h}; C_3(z)$
- $C_{3h}; C_2^2(y)$
- $D_{3h}; \sigma_{xy}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$D_{3h}; C_3(z)$

8) What is the matrix representation of the product  $\sigma_{xy}\sigma_{yz}$ ?

1 point

- $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$
- $\begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{pmatrix}$
- $\begin{pmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$
- $\begin{pmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{pmatrix}$

No, the answer is incorrect.

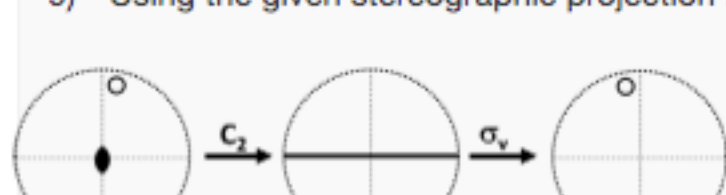
Score: 0

Accepted Answers:

$$\begin{pmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{pmatrix}$$

9) Using the given stereographic projection find the correct answer. [given:  $\sigma_v$  and  $\sigma'_v$  are perpendicular to each other]

1 point



- $\sigma_v C_2 = \sigma'_v$
- $C_2 E = \sigma'_v$
- $C_2 E = E$
- $C_2 I = \sigma_v$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$\sigma_v C_2 = \sigma'_v$

10) Which one of the symmetry operations can be represented with an identity matrix?

1 point

- $C_2$
- $S_3$
- E
- $\sigma_v$

No, the answer is incorrect.

Score: 0

Accepted Answers:

E