

Bielefeld University Faculty of Physics	Symmetries in Physics WS 2025/2026	Prof. Dr. Jürgen Schnack jschnack@uni-bielefeld.de
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3 Problem sheet

3.1 IN CLASS: Mathematical preliminaries

- Read Chapter 2 on Mathematical preliminaries in Lym 2022.
- Define and discuss all technical terms listed in my lecture notes.

3.2 AT HOME: C_{3v}

- Look up the group C_{3v} and copy its definition.
- Characterize the group elements. Make a graphical sketch.
- Set up the group table.
- Is the group Abelian? What is the order of the group?
- Are there subgroups?
- Try to formulate cosets, conjugacy classes, normal subgroups, and quotient groups, if they exist. This is a **very important** task. Do not look this up (too early), try it step by step, and if you look it up at some point, try hard to understand how to obtain the result.
- Can you figure out a similarity to the permutation of three numbers, say 1, 2, 3?

3.3 AT HOME: What is this operation?

- Show how $\exp\left\{-\frac{i}{\hbar}ap_{\sim}\right\}$ for $a \in \mathbb{R}$ acts on a wave function.
- Does this define a group? Can you show the properties of the group?
- Can this easily be generalized to 3 spacial dimensions? How? And why easy?