1. Let $G$ be the group $S_3$ and let $K$ be the subgroup $\{ e, \tau \}$ where $\tau = (23)$, the permutation which interchanges 2 and 3 but fixes 1. List the distinct right cosets of $K$. How many are there?

2. A biophysical chemist studying a complicated molecule (as a three-dimensional object) wants to know whether or not spatial rotation of the molecule 36 degrees around the z-axis produces the exact same configuration of atoms (ie, is a symmetry of the molecule).\(^1\) Searching the literature, she has found a research paper which concludes, based on experimental data, that the symmetry group of the molecule is has a subgroup of index seven isomorphic to $D_4 \times \mathbb{Z}_2$. She knows you’re a math whiz and asks for help. Can you? Does she need more information or is the answer already clear? Explain fully!!

\(^1\)If so, it might bond with certain proteins common to all mammals to help slow the growth of tumors in her collaborators’ lab rats!