1. Let \( X \) be the space obtained by gluing the northpole of \( S^2 \) to the south pole of \( S^2 \). Calculate \( \pi_1(X) \).

2. Let \( X \) be the union of \( n \) lines through the origin in \( \mathbb{R}^3 \). Compute \( \pi_1(\mathbb{R}^3 - X) \).

3. Let \( F \) be a finitely generated free group, and \( N \) an infinite index normal subgroup. Show that \( N \) is not finitely generated, using covering space theory.

4. Let \( M \) be a path connected 3-manifold and let \( x, y \in M \).
   a) Prove that \( \pi_1(M, y) \) is isomorphic to \( \pi_1(M - \{x\}, y) \).
   b) Is the same statement true for all \( n \)-manifolds and all \( n \in \mathbb{Z}_+ \)?

5. Let \( S \) be a compact surface (without boundary) with \( n \) points deleted, a so-called punctured surface with \( n \) punctures. Show that the fundamental group of \( S \) is a free group if \( N \geq 1 \). What is the number of generators?