Please let me know if any of the problems are unclear or have typos.

Exercise 4.1. Copy the proof of Alexander's theorem to give a proof of the easy part of the Jordan-Schoenflies theorem in dimension two: Every smooth curve in S^2 divides the sphere into two connected components. The closure of each is a disk.

Exercise 4.2. Suppose that $S \subset S^3$ is a smoothly embedded two-sphere. Let $h\colon \mathbb{R}^3 \to \mathbb{R}$ be the projection onto the third coordinate. Define $H = h|S$ and suppose that H is Morse. Suppose that c is a critical value of H and ϵ is sufficiently small. Suppose C is a connected component of $H^{-1}([c-\epsilon, c+\epsilon])$. Classify the possible homeomorphism types for C, including how it embeds into and separates the region $P = h^{-1}([c-\epsilon, c+\epsilon])$.

Exercise 4.3. Suppose that $S, S' \subset \mathbb{R}^3$ are smoothly embedded two-spheres. Show that there is an ambient isotopy taking S to S'. [Finding a diffeotopy is harder.]

Exercise 4.4. [Hard.] Compute the homotopy type of $\mathrm{Emb}(S^2, S^3)$, the space of smooth embeddings of the two-sphere into the three-sphere.

Exercise 4.5. Suppose that $T \subset S^3$ is a smoothly embedded two-torus. Show that T bounds a solid torus on at least one side.