1. (25 points) Let $X$ be the union of the unit 3-sphere (centered at the origin) with the z-axis. Compute $\pi_1(X)$.

2. (25 points) Let $X$ be the space obtained from a triangle $PQR$ and its interior by identifying edges in the following way: identify $\overrightarrow{PQ}$ with $\overrightarrow{QR}$, and identify $\overrightarrow{PQ}$ with $\overrightarrow{PR}$. Compute $H_2(X)$.

3. (25 points) For each of the following either give an example or indicate why no example exists.

   (a) A connected space $X$ such that $\pi_1X$ is a non-trivial finite group.

   (b) A space $X$ such that $H_2X$ is a non-trivial finite group.

   (c) A retraction from the 2-sphere to the circle on the equator.

   (d) A self-map of the 2-sphere with no fixed points.

4. (25 points) Let $X = S^1 \vee S^1$ denote the one-point union of two circles. Classify all the 2-sheeted covering spaces over $X$, up to equivalence of covering spaces: draw a picture of each type of covering, and give a justification that these are the only ones.