1. Answer each of the following. (Two points each.)
   (a) What is the product topology?
   (b) What is the quotient topology?
   (c) State the Extreme Value Theorem in its most general form.
   (d) What is a limit point?
   (e) State the Urysohn Lemma.

2. Let $\mathcal{T}$ and $\mathcal{T}'$ be two topologies on a set $X$ with $\mathcal{T} \subseteq \mathcal{T}'$. Does $(X, \mathcal{T})$ being connected imply $(X, \mathcal{T}')$ is? What about the reverse implication? Prove all claims.

3. State and prove the Uniform Continuity Theorem.

4. We wish to form a torus by gluing the opposite edges of a square region together. Write this out formally using a quotient map.

5. Prove the Sequence Lemma: Let $X$ be a topological space. Let $A \subseteq X$. If there is a sequence of points in $A$ converging to $x$, then $x \in \bar{A}$. The converse holds if $X$ is a metric space.

6. Show that $\mathbb{R}^\omega$ in the box topology is not metrizable. Hint: exploit the Sequence Lemma.

7. Prove the continuous image of a compact space is compact. Give an example showing that the continuous image of a closed set need not be closed.

8. State and prove the Lebesgue Number Lemma.

9. What is the fundamental group of $S^2 \times S^1$?

10. Let $B^2$ be the closed unit two-dimensional ball. Prove that there is no retraction from $B^2$ to $S^1$. 