1. (Answer 5 of the 9, for 2 points each.)
   a) Define cardinality.
   b) State the Well-ordering Theorem.
   c) State the Axiom of Choice.
   d) State the Maximum Principle.
   e) Define metric space.
   f) Define quotient map.
   g) Define $m$-dimensional manifold.
   h) Define strong deformation retract.
   i) Define covering map.

2. Prove that every metrizable space is normal.

3. Prove that $\mathbb{Q}$, the rational numbers, is not locally compact.

4. State and prove the Lebesgue Number Lemma.

5. Give an example showing that the product of two quotient maps need not be a quotient map.

6. Show that every uncountable subset of the real line has a limit point.

7. Prove that the connected subsets of the real line are intervals (or one-point sets).

8. Prove that every one-point subset of a Hausdorff space is closed.

9. Let $X$ and $Y$ be topological spaces; let $x \in X$ and $y \in Y$. Prove that
   \[ \pi_1(X \times Y, (x, y)) \cong \pi_1(X, x) \times \pi_1(Y, y). \]

10. Prove that if $p : E \longrightarrow B$ is a covering map, then $p$ is an open map.