1. If $A$ and $B$ are sets, prove:
   
   (a) $(A \setminus B) \cup (B \setminus A) = (A \cup B) \setminus (A \cap B)$.
   
   (b) $A \cap B$ and $A \setminus B$ are disjoint, and $A = (A \cap B) \cup (A \setminus B)$.

2. Let $f : A \to B$ and $g : B \to C$ be functions. Prove each of the following.
   
   (a) If both $f$ and $g$ are injective, then $g \circ f$ is injective.
   
   (b) If both $f$ and $g$ are surjective, then $g \circ f$ is surjective.

3. Let $a_1 = 1$ and define $a_2, a_3, \ldots$ inductively by $a_{n+1} = \sqrt{2 + \sqrt{a_n}}$. Prove each of the following assertions by induction.
   
   (a) For all $n$, $0 < a_n < 2$.
   
   (b) For all $n$, $a_n < a_{n+1}$.

4. Prove that $\sqrt{3}$ and $\sqrt{6}$ are irrational.

5. Prove there exists a real number $r$ such that $r^2 = 2$. (Hint: Consider the set $A = \{x \in \mathbb{R} : x > 0, \; x^2 < 2\}$.)