

Note: Structure your proofs by stating the full "**Proposition:**" followed by "**Proof:**" as in class, and please start each new proof on a new page. Indent your argument where appropriate for readability and be careful with notation.

As with any proof, clarity of presentation is as important as solving the problem. Strive to make your proofs clear, concise and precise. Feel free to use results from earlier problems in subsequent ones.

Finally, proofs for many of the problems in this course are likely available online if one looks hard enough, but the point of this course is to learn analysis, and in particular how to write analysis proofs. As such, please resist turning to the internet for help except as a last resort; instead, discuss solutions among your peers or see me for hints.

1. Show that $W \cap (U \cup V) = (W \cap U) \cup (W \cap V)$.
2. Let $p_1 < p_2 < p_3 < \dots$ be an ordered enumeration of the prime numbers and for each $k \in \mathbb{N}$ define $A_k = \{p_k n : n \in \mathbb{N}\}$. Find (with proof) $\bigcap_{k \in \mathbb{N}} A_k$.
3. If $B \subset A$ show that $B = A \setminus (A \setminus B)$.
4. Show that $A \cap B = A \setminus (A \setminus B)$.
5. Prove using induction that $1^3 + 2^3 + 3^3 + \dots + n^3 = \frac{n^2(n+1)^2}{4}$ for every $n \in \mathbb{N}$.
6. Let $f : A \rightarrow B$ and suppose that C, D are subsets of A . Prove that
 - (a) $f(C \cup D) = f(C) \cup f(D)$
 - (b) $f(C \cap D) \subset f(C) \cap f(D)$
 - (c) Give an example in which $f(C \cap D) \subsetneq f(C) \cap f(D)$
7. Textbook exercise 0.3.10.
8. Suppose $f : X \rightarrow Y$. Prove that $f^{-1}(f(A)) = A$ for every $A \subset X$ if and only if f is injective.
9. Give an example of a function f and sets A, X and Y such that $A \subset X$ yet $f^{-1}(f(A)) \neq A$.
10. Let $f : A \setminus B \rightarrow B \setminus A$ be a bijection. Find a bijection $g : A \rightarrow B$ and prove your result.