

1. **Definition:** A **mathematical proof** is a logical argument that demonstrates the truth of a statement. It is a sequence of statements, each of which is either an axiom or follows from the previous statements by a rule of inference.

2. **Types of Proofs:**

- Direct Proof:** A direct proof shows that a statement is true by assuming the hypothesis and deducing the conclusion.
- Indirect Proof:** An indirect proof shows that a statement is true by assuming the opposite and deriving a contradiction.
- Proof by Contradiction:** A proof by contradiction shows that a statement is true by assuming the opposite and deriving a contradiction.
- Proof by Cases:** A proof by cases shows that a statement is true by considering all possible cases and showing that the statement is true in each case.
- Proof by Induction:** A proof by induction shows that a statement is true for all natural numbers by showing that it is true for the base case and that it follows from the previous case.

3. **Importance of Proofs:** Proofs are essential in mathematics because they provide a rigorous way to establish the truth of a statement. They also help to organize and clarify mathematical ideas.

4. **Examples of Proofs:**

- Example 1:** Prove that the sum of two even numbers is even.

Proof: Let $2m$ and $2n$ be even numbers. Then their sum is $2m + 2n = 2(m + n)$, which is even.
- Example 2:** Prove that the sum of two odd numbers is even.

Proof: Let $2m + 1$ and $2n + 1$ be odd numbers. Then their sum is $(2m + 1) + (2n + 1) = 2m + 2n + 2 = 2(m + n + 1)$, which is even.

5. **Conclusion:** Proofs are a fundamental part of mathematics and are used to establish the truth of mathematical statements. They are also a valuable tool for organizing and clarifying mathematical ideas.

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