Exercise 1. Show that the set $\mathbb{Z}$ is countably infinite.

Exercise 2. Given a permutation

$$\pi = \begin{pmatrix} 1 & 2 & 3 \\ 2 & 3 & 1 \end{pmatrix}$$

on a set $S = \{1, 2, 3\}$, define an inverse permutation π^{-1}.

Exercise 3. Let $f(x) = x^2$ and $g(x) = 2x + 5$. Define compositions $(f \circ g)(x)$ and $(g \circ f)(x)$. Are they the same?

Exercise 4. Let $f(x) = x^3$ and $g(x) = \sqrt[3]{x}$. Define compositions $(f \circ g)(x)$ and $(g \circ f)(x)$. Are they the same?

Exercise 5. Let $h : S \to T$ be a bijection, and let h^{-1} be its inverse. What are the mappings $h \circ h^{-1}$ and $h^{-1} \circ h$?

Exercise 6. Let A and B be sets. Let $A' \subset A$ and $I : A' \to A'$. Is the composition $f \circ I$ the same as the restriction of f to A'?

Definition 1 (Restriction of a mapping to a subset)**.** If $f : A \to B$ is a mapping and $A' \subset A$, the mapping $f' : A' \to B$ given by $x \mapsto f(x)$ for $x \in A'$ is called the restriction of f to A'.

Exercise 7. Let $f : A \to B$ and $g : B \to C$. If $g \circ f$ is injective, show that f is injective.

Exercise 8. Let $f : A \to B$ and $g : B \to C$. If $g \circ f$ is injective and f is surjective, show that g is injective.

Exercise 9. Let $f : A \to B$ and $g : B \to C$. If $g \circ f$ is surjective and g is injective, show that f is surjective.

Exercise 10. Let A and B be sets. Let $f : A \to B$ and $g : B \to A$ be mappings. If $f \circ g = id_B$, show that f is surjective.

Exercise 11. Let A and B be sets. Let $f : A \to B$ and $g : B \to A$ be mappings. If $g \circ f = id_A$, show that f is injective.