Name: ...........................................................................................................

**Notation:** $\mathbb{R} = \{\text{real numbers}\}$, $\mathbb{Z} = \{\text{integers}\}$, $\mathbb{N} = \{\text{non-negative integers}\} = \{0, 1, 2, 3, \dots\}$.
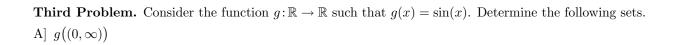
**First Problem.**
Suppose that $X$ and $Y$ are sets, $\varphi: X \to Y$ is a function, $W$ is a subset of $X$ and $Z$ is a subset of $Y$. Write the definitions of $\varphi(W)$ and of $\varphi^{-1}(Z)$.

**Second Problem.** Consider the function $f: \mathbb{R} \to \mathbb{R}$ such that $f(x) = x^2$. Determine the following sets.

A] $f\big((-\infty, 57)\big)$

B] $f^{-1}\big([-4, -1]\big)$

C] $f^{-1}\big([1, 4]\big)$

D] $f^{-1}\big(\{144\}\big)$

**Third Problem.** Consider the function $g:\mathbb{R} \to \mathbb{R}$ such that $g(x) = \sin(x)$. Determine the following sets.

A] $g\big((0, \infty)\big)$

B] $g^{-1}(\mathbb{Z})$

**Fourth Problem.** Consider the function $h:\mathbb{N} \times \mathbb{N} \to \mathbb{R}$ such that $h(a, b) = a + b$. What is $h^{-1}\big([0, 3]\big)$?