**(Q2)**
*(a)(i)*

*Proof.* Since $f \circ g$ is invertible, it must be bijective and thus injective and surjective.
By the definition of surjectivity of $f \circ g$:

$$\forall y \in Z, \exists x \in X \text{ s.t. } f(g(x)) = y$$

Since by this definition, $f$ maps from every member in $g(X)$ to its codomain $Z$, it must be surjective. ■

*(a)(ii)*

*Proof.* By earlier definition, $f \circ g$ is injective and surjective.
Aiming for a contradiction, suppose that $g$ is not injective. Thus:

$$\exists x_1, x_2 \in X \text{ s.t. } g(x_1) = g(x_2) \text{ and } x_1 \neq x_2$$

Then $g(x_1) = g(x_2) \implies f(g(x_1)) = f(g(x_2))$. However, simultaneously, $x_1 \neq x_2$. Thus, we have

$$f(g(x_1)) = f(g(x_2)) \text{ and } x_1 \neq x_2$$

Which suggests $f \circ g$ is not injective.
This is a contradiction, and thus $g$ must be injective. ■

*(b)*
Let $g\colon \mathbb{R} \to \mathbb{R}$ be given by $g(x) = e^x$, and $f\colon \mathbb{R} \to (0, \infty)$ be given by $f(x) = x^2$. Thus, $f \circ g\colon \mathbb{R} \to (0, \infty)$ is given by $f(g(x)) = (e^x)^2 = e^{2x}$, which is bijective and is therefore invertible.