1. Define $f : \mathbb{R} \to \mathbb{R}$ by
   \[ \forall x \in \mathbb{R} \ (f(x) = \sin x) \]
   where $x$ is measured in radians.
   Give
   i) $\text{dom } f$
   ii) $\text{im } f$
   iii) $\text{range } f$
   iv) $f([0, 1])$
   v) $f^{-1}([0])$
   vi) $f^{-1}([0, 1])$
   vii) $f^{-1}(f([0, 1]))$

2. Let $f : A \to B$. Prove that
   i) $f$ is injective iff $f(a) = f(a') \implies a = a'$
   ii) $f$ is surjective iff $\text{im } f = B$

3. Let $f : A \to B$. Suppose $\exists g : B \to A$ such that both
   \[ g \circ f = \iota_A \]
   and
   \[ f \circ g = \iota_B \]
   Prove that $f$ is bijective and $f^{-1} = g$.

4. (Extra credit–you need not hand in) Let $f : A \to B$ and define $f^{-1} : \mathcal{P}(B) \to \mathcal{P}(A)$ as usual. Then this $f^{-1}$ preserves inclusions, unions, intersections and set differences. Of these four properties, the function $f : \mathcal{P}(A) \to \mathcal{P}(B)$ preserves inclusions and unions only.