Exercise 1. Determine which of the following functions are injective and which are surjective.

(a) $f : \mathbb{R} \to \mathbb{R}$ defined by $f(x) = e^x$.

(b) $f : \mathbb{Z} \to \mathbb{Z}$ defined by $f(n) = n^2 + 3$.

(c) $f : \mathbb{R} \to \mathbb{R}$ defined by $f(x) = \sin x$.

(d) $f : \mathbb{Z} \to \mathbb{Z}$ defined by $f(x) = x^2$.

(e) $f : \mathbb{Z} \to \mathbb{Q}$ defined by $f(n) = n/1$.

(f) $f : \mathbb{Q} \to \mathbb{Z}$ defined by $f(p/q) = p$, where p/q is a rational number expressed in its lowest terms with a positive denominator.

(g) $f : \mathbb{Z} \to \mathbb{Z}$ defined by $f(x) = 2x$.

Exercise 2. Is relation $f \subseteq \mathbb{Q} \times \mathbb{Z}$ given by $f\left(\frac{p}{q}\right) = p$ a mapping?

Exercise 3. Is the relation $f \subseteq \mathbb{Z} \times \mathbb{Z}$ defined by $f(x) = 2x$ a mapping?

Exercise 4. Is the relation $f \subseteq \mathbb{Z} \times \mathbb{Z}$ defined by $f(x) = \frac{x}{2}$ a mapping?

Exercise 5. Which of the following relations $f \subseteq \mathbb{Q} \times \mathbb{Q}$ define a mapping? If f is not a mapping, supply a reason for it.

$$(a) \quad f\left(\frac{p}{q}\right) = \frac{p+1}{p-2} \qquad\qquad (b) \quad f\left(\frac{p}{q}\right) = \frac{3p}{2q}$$

$$(c) \quad f\left(\frac{p}{q}\right) = \frac{p+q}{q^2} \qquad\qquad (d) \quad f\left(\frac{p}{q}\right) = \frac{3p^2}{7q^2} - \frac{p}{q}$$