

**Exercises 0:** 11, 14, 16, 17, 19, 20a, 30, 32

**Exercises 2:** 37

**Additional exercises:**

1. Determine whether the following maps are invertible.
  - (a)  $\phi : \mathbb{R} \rightarrow \mathbb{R}$ , where  $\phi(x) = \frac{5+3x}{2}$
  - (b)  $\phi : \mathbb{R} \rightarrow \mathbb{R}$ , where  $\phi(x) = x^2 - 4$ .
2. Let  $\phi : A \rightarrow B$ ,  $\chi : B \rightarrow C$ , and  $\psi : C \rightarrow D$  be maps. Prove each of the following statements.
  - (a) If  $\chi \circ \phi$  is surjective, then  $\chi$  must be surjective.
  - (b) If  $\chi \circ \phi$  is injective, then  $\phi$  must be injective.
  - (c)  $\psi \circ (\chi \circ \phi) = (\psi \circ \chi) \circ \phi$ .
  - (d) If  $\phi$  and  $\chi$  are both surjective, then  $\chi \circ \phi$  is surjective.
  - (e) If  $\phi$  is invertible, then  $\phi$  is injective and surjective.
  - (f) If  $\phi$  and  $\chi$  are both invertible, then  $\chi \circ \phi$  is invertible and  $(\chi \circ \phi)^{-1} = \phi^{-1} \circ \chi^{-1}$ .