1. *Munkres, §51, Exercise 3*
   A topological space $X$ is said to be *contractible* if the identity map $i_X : X \to X$ is nullhomotopic (homotopic to a constant map).
   (a) Show that $[0,1]$ and $\mathbb{R}$ are contractible.
   (b) Show that a contractible space is path connected.
   (c) Let $[X,Y]$ be the set of homotopy classes of maps $X \to Y$. Show that if $Y$ is contractible, then for any $X$, the set $[X,Y]$ has a single element.
   (d) Show that if $X$ is contractible and $Y$ is path connected, then $[X,Y]$ has a single element.

2. *Munkres, §52, Exercise 4*
   Given $A \subset X$, a continuous map $r : X \to A$ is called a *retraction* if $r(a) = a$ for every $a \in A$. If $a_0 \in A$ and $r$ is a retraction of $X$ onto $A$, show that $r_* : \pi_1(X,a_0) \to \pi_1(A,a_0)$ is surjective. Give an example to show that $r_*$ may not be injective.

3. *Munkres, §53, Exercise 5*
   Fix $n \in \mathbb{N}$ and let $p : S^1 \to S^1$ be the map $p(z) = z^n$. Show that $p$ is a covering map. What is $\# p^{-1}(z)$?

4. *Munkres, §54, Exercise 5*
   Consider the covering map $p : \mathbb{R}^2 \to \mathbb{T}^2 = S^1 \times S^1$ given by $p(x,y) = (e^{2\pi ix}, e^{2\pi iy})$. Consider the path $\gamma(t) = (e^{2\pi it}, e^{4\pi it})$ on $\mathbb{T}^2$. Sketch what $\gamma$ looks like when $\mathbb{T}^2$ is identified with the “doughnut” surface in $\mathbb{R}^3$. Find two different liftings $\tilde{\gamma}$ of $\gamma$ to $\mathbb{R}^2$, and sketch them.

5. *Munkres, §54, Exercise 8*
   Let $p : E \to B$ be a covering map, with $E$ path connected. Show that if $B$ is simply connected, then $p$ is a homeomorphism.