The required problems are Exercises 5.2 and 5.3 and the first two parts of Exercise 5.5. Please let me know if any of the problems are unclear or have typos.

Exercise 5.1. Define the punctured plane to be $\mathbb{C}^\times = \mathbb{C} - \{0\}$. Show that the map $p\colon \mathbb{C}^\times \to \mathbb{C}^\times$ defined by $p(z) = z^2$ is a covering map. Explain why the squaring map on $\mathbb{C}$ itself is not a covering map.

Exercise 5.2. [Exercise 12, page 39, of Hatcher.] Show that for every homomorphism $\phi\colon \pi_1(S^1, 1) \to \pi_1(S^1, 1)$ there is a pointed map $f\colon (S^1, 1) \to (S^1, 1)$ so that $\phi = f_*$. In other words, f induces ϕ.

Exercise 5.3. Suppose that $p\colon \widetilde{X} \to X$ is a covering map, and suppose that $\widetilde{X}$ is path-connected. Show that $\tau \in \mathrm{Deck}(p)$ fixes a point of $\widetilde{X}$ if and only if $\tau = \mathrm{Id}_{\widetilde{X}}$.

Exercise 5.4. Suppose that $p\colon \mathbb{R} \to S^1$ is the usual covering map, namely $p(t) = \exp(2\pi i t)$. Give a complete proof that $\mathrm{Deck}(p) \cong \mathbb{Z}$.

Exercise 5.5. [Exercise 16, page 39, of Hatcher.] Show that there is no retraction $r\colon X \to A$ in any of the following cases. (Give short justifications of any fundamental group computations.)

- $X = \mathbb{R}^3$ with A any subspace homeomorphic to S^1.
- $X = S^1 \times D^2$ with A its boundary torus $S^1 \times S^1$.
- $X = S^1 \times D^2$ and A the circle shown in the figure. [See book.]
- $X = D^2 \vee D^2$ with A its boundary $S^1 \vee S^1$.
- X a disk with two points on its boundary identified and A its boundary $S^1 \vee S^1$.
- X the Möbius band and A its boundary circle.

Exercise 5.6. [Perron–Frobenius] Suppose that A is a real three-by-three matrix, with all entries positive. Show that A has an eigenvector with all entries positive.