3.1 Let A, B, C be objects in C and hence objects in C^{op}. Let $f \in \mathsf{Hom}_{\mathsf{C}^{op}}(A, B)$ and $g \in \mathsf{Hom}_{\mathsf{C}^{op}}(B, C)$. Thus $f \in \mathsf{Hom}_{\mathsf{C}}(B, A)$ and $g \in \mathsf{Hom}_{\mathsf{C}}(C, B)$. Since C is a category, the morphism $f \circ_{\mathsf{C}} g$ exists in C. Define $\circ_{\mathsf{C}^{op}}$ as $g \circ_{\mathsf{C}^{op}} f := f \circ_{\mathsf{C}} g$. We are guaranteed that the composition of morphisms exists since C is a category. We gain associativity for the same reason. The composition of identity in C^{op} becomes composition of identity on the other side in C, which is still an identity.

3.2 $\mathsf{End}_{\mathsf{Set}}(A)$ is defined as $\mathsf{Hom}_{\mathsf{Set}}(A, A)$. This is the set of all set-functions $A \to A$; in other words, the set A^A. Thus $|\mathsf{End}_{\mathsf{Set}}(A)| = |A^A| = |A|^{|A|}$ (the last equality from a previous exercise.)

3.3 Let $f : a \to b$ be some morphism. Want to show that $f \circ 1_a =_{(1)} f =_{(2)} 1_b \circ f$.

(1). $1_a = (a, a) \implies a \sim a$, $f = (a, b) \implies a \sim b$. The transitive property allows us to conclude that $a \sim b$, picking that as the composition, so $1_a \circ f = f$.

(2). $f = (a, b) \implies a \sim b$, $1_b = (b, b) \implies b \sim b$. The transitive property gives us that $a \sim b$, which corresponds to f. So $f \circ 1_b = f$.

3.5 Example 3.3 describes a category of a set of objections with a reflexive, transitive relation between them. $\hat{\mathsf{S}}$ has a set of objects, the objects being subsets of S. The reflexive, transitive relation is $\subseteq$. In all aspects it takes the form of the abstract category described in Example 3.3.