We introduce invariants of spatial graphs which are a generalization of the Simon invariant for embeddings of $K_5$ and $K_{3,3}$ in $S^3$. Then we use our invariants to prove that $K_7$, all Möbius ladders with an odd number of rungs, and the Heawood graph each have the property that all of their embeddings in $S^3$ are chiral. We also use our invariants to obtain lower bounds for the minimal crossing number of particular embeddings of graphs in $S^3$. (Received December 20, 2016)