We consider all orientation-preserving $\mathbb{Z}_{p^2}$-actions, where $p$ is prime, on 3-dimensional handlebodies $V_g$ of genus $g \geq 1$. We study the graph of groups $(\Gamma, G)$, which determines a handlebody orbifold $V(\Gamma(v), G(v)) \simeq V_g/\mathbb{Z}_{p^2}$. This algebraic characterization is used to enumerate the total number of $\mathbb{Z}_{p^2}$ group actions on such handlebodies, up to equivalence. (Received August 25, 2015)