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We define effective resistance for high-dimensional networks following Kirchhoff's laws, and provide two formulas. One of them provides a combinatorial interpretation via top-dimensional tree numbers, and the other is an elegant consequence of Kirchhoff's equation in codimension 1. These results are natural generalizations of those for ordinary networks, and can be used in formulating high-dimensional analogues of related network invariants. As an application, we will suggest a definition of information centrality for top-dimensional simplices. (Received August 30, 2016)