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We study Einstein metrics on smooth compact 4-manifolds with an edge-cone singularity of specified cone angle along an embedded 2-manifold. To do so, we first derive modified versions of the Gauss-Bonnet and signature theorems for arbitrary Riemannian 4-manifolds with edge-cone singularities, and then show that these yield non-trivial obstructions in the Einstein case. We then use these integral formulæ to obtain interesting information regarding gravitational instantons which arise as limits of such edge-cone manifolds. (Received February 11, 2013)