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A regular matroid is a matroid which can be represented by a matrix over any field. Regular matroids enjoy many elegant properties that ordinary matroids do not, so it is often of interest to determine when a given matroid is regular. We give three distinct characterizations of regular matroids among orientable ones. The main result is stated in terms of lattice theory: an orientable matroid is regular if and only if the fundamental circuits of each basis generate the same lattice. Several enumerative results follow as corollaries to this lattice-theoretic characterization. The main such corollary is that a matroid is regular if and only if the number of integrally independent cocircuits is exactly equal to the rank of the matroid. In addition, we prove that a matroid is regular if and only if all of its circuits and cocircuits are orthogonal with respect to the standard inner product on \mathbb{R}^n . Each of these characterizations gives a parameter measuring “how far” the matroid is from being regular, so they seem to provide richer combinatorial information than previous characterizations. (Received August 14, 2017)