Before the advent of integral calculus, mathematicians found areas and volumes of curved shapes by slicing them into infinitely many indivisible slices and then... performing a variety of creative hijinks. We will survey some extraordinary examples of the method of indivisibles used by Archimedes, Liu Hui, Zu Gengzhi, Bonaventura Cavalieri, and Evangelista Torricelli. We will also investigate what indivisibles can’t do, and why they needed to be replaced by infinitesimals in order to do calculus.