From Instantaneous Pumping Rate to Total Volume

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Abstract:

The purpose of this article is to entice students who plan to major in science or engineering to enroll in first semester calculus. This goal is achieved by constructing a physical example in which water is pumped into a tank at an instantaneous pumping rate. Next, the focus gently shifts from an instantaneous pumping rate to the total volume of water pumped over several hours to introduce a basic concept of calculus, integration. Integration is visualized in terms of the total volume of water pumped over time. The time during which water is pumped into a tank is divided into consecutive intervals. The volume of water pumped during an interval is approximately equal to the instantaneous pumping rate at the end of an interval times the width of the interval. The total volume pumped is approximately the sum of the volumes pumped during all intervals. Numerical examples demonstrate that as the widths of the intervals are decreased, the total volume pumped approaches the area under the curve formed by graphing the instantaneous pumping rate as a function of time. The article concludes by defining this limiting area as a definite integral.

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