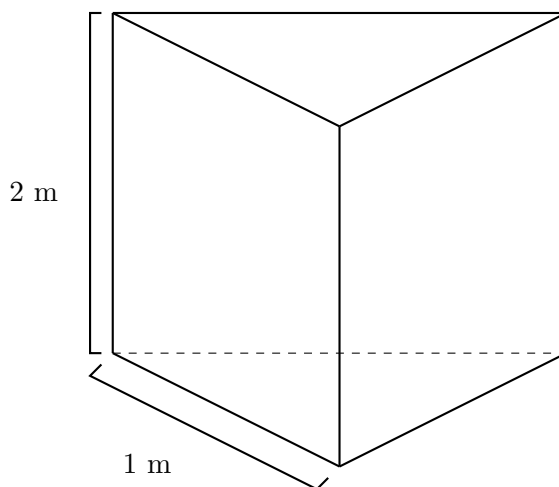


9. [9 points] The tank pictured below has height 2 meters, and the top and bottom are equilateral triangles with sides of length 1 meter. It is filled **halfway** with hot chocolate. The hot chocolate has uniform density  $1325 \text{ kg/m}^3$ . The acceleration due to gravity is  $9.8 \text{ m/s}^2$ . Calculate the work needed to pump all the chocolate to the top of the tank. Show all your work. Give an **exact** answer. Include **units**.



*Solution:* We take a horizontal slice at height  $y$  meters from the bottom of the tank. It has mass  $1325 \cdot \frac{\sqrt{3}}{4} 1^2 \Delta y$ . We need to move it  $2 - y$  meters up. Thus, the work needed to pump all the chocolate to the top is

$$\int_0^1 1325 \cdot \frac{\sqrt{3}}{4} 1^2 \cdot 9.8 \cdot (2 - y) dy = \frac{1325 \cdot 9.8 \sqrt{3}}{4} \left[ 2y - \frac{y^2}{2} \right]_{y=0}^{y=1} = \frac{1325 \cdot 9.8 \sqrt{3}}{4} \cdot \frac{3}{2} \text{ Joules}$$