

## Riemann Sum Warm-up

1. The table gives the values for the rate (in gal/sec) at which water flowed into a lake, with readings taken at specific times. Use Trapezoidal Approximations, with the five subintervals indicated by the data in the table, is used to estimate the total amount of water that flowed into the lake during the time period. What is the estimate?

Time (sec)	0	10	25	37	46	60
Rate (gal/sec)	500	400	350	280	200	180

2. The table gives the values for the rate (in gal/sec) at which water flowed into a lake, with readings taken at specific times. Use a Right Riemann Sum, with the five subintervals indicated by the data in the table, is used to estimate the total amount of water that flowed into the lake during the time period. What is the estimate?

Time (sec)	0	10	25	37	46	60
Rate (gal/sec)	500	400	350	280	200	180

3.

t (minutes)	0	4	9	15	20
W(t) (degrees Fahrenheit)	55	57.1	61.8	67.9	71

The temperature of water in a tub at time  $t$  is modeled by a strictly increasing, twice differentiable function  $W$ , where  $W(t)$  is measured in degrees Fahrenheit and  $t$  is measured in minutes. At time  $t = 0$ , the temperature of the water is  $55^\circ F$ . The water is heated for 30 minutes, beginning at time  $t = 0$ . Values of  $W(t)$  at selected times  $t$  for the first 20 minutes are given in the table above.

- a) Use the data in the table to estimate  $W'(12)$ . Show the computations that lead to your answer. Using correct units, interpret the meaning of your answer in the context of this problem.

- b) Use the data in the table to evaluate  $\int_0^{20} W'(t) dt$ . Using correct units, interpret the meaning of  $\int_0^{20} W'(t) dt$  in the context of this problem.

- c) For  $0 \leq t \leq 20$ , the average temperature of the water in the tub is  $\frac{1}{20} \int_0^{20} W(t) dt$ . Use a left Riemann Sum with four subintervals indicated by the data in the table to approximate  $\frac{1}{20} \int_0^{20} W(t) dt$ . Does this approximation overestimate or underestimate the average temperature of the water over these 20 minutes? Explain your reasoning.

- d) For  $20 \leq t \leq 25$ , the function  $W$  that models the water temperature has first derivative given by  $W'(t) = 0.4\sqrt{t} \cos(0.06t)$ . Based on the model, what is the temperature of the water at time  $t = 25$ ?