

1.

Traffic flow is defined as the rate at which cars pass through an intersection, measured in cars per minute. The traffic flow at a particular intersection is modeled by the function  $F$  defined by

$$F(t) = 82 + 4\sin\left(\frac{t}{2}\right) \text{ for } 0 \leq t \leq 30,$$

where  $F(t)$  is measured in cars per minute and  $t$  is measured in minutes.

- To the nearest whole number, how many cars pass through the intersection over the 30-minute period?
- Is the traffic flow increasing or decreasing at  $t = 7$ ? Give a reason for your answer.
- What is the average value of the traffic flow over the time interval  $10 \leq t \leq 15$ ? Indicate units of measure.
- What is the average rate of change of the traffic flow over the time interval  $10 \leq t \leq 15$ ? Indicate units of measure.

2.

A water tank at Camp Newton holds 1200 gallons of water at time  $t = 0$ . During the time interval  $0 \leq t \leq 18$  hours, water is pumped into the tank at the rate

$$W(t) = 95\sqrt{t} \sin^2\left(\frac{t}{6}\right) \text{ gallons per hour.}$$

During the same time interval, water is removed from the tank at the rate

$$R(t) = 275 \sin^2\left(\frac{t}{3}\right) \text{ gallons per hour.}$$

- Is the amount of water in the tank increasing at time  $t = 15$ ? Why or why not?
- To the nearest whole number, how many gallons of water are in the tank at time  $t = 18$ ?
- At what time  $t$ , for  $0 \leq t \leq 18$ , is the amount of water in the tank at an absolute minimum? Show the work that leads to your conclusion.
- For  $t > 18$ , no water is pumped into the tank, but water continues to be removed at the rate  $R(t)$  until the tank becomes empty. Let  $k$  be the time at which the tank becomes empty. Write, but do not solve, an equation involving an integral expression that can be used to find the value of  $k$ .

3.

The rate of consumption of cola in the United States is given by  $S(t) = Ce^{kt}$ , where  $S$  is measured in billions of gallons per year and  $t$  is measured in years from the beginning of 1980.

- (a) The consumption rate doubles every 5 years and the consumption rate at the beginning of 1980 was 6 billion gallons per year. Find  $C$  and  $k$ .
- (b) Find the average rate of consumption of cola over the 10-year time period beginning January 1, 1983. Indicate units of measure.
- (c) Use the trapezoidal rule with four equal subdivisions to estimate  $\int_5^7 S(t) dt$ .
- (d) Using correct units, explain the meaning of  $\int_5^7 S(t) dt$  in terms of cola consumption.