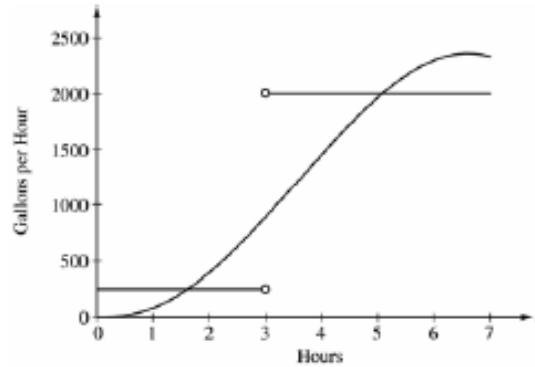


Let  $v(t)$  be the velocity, in feet per second, of a skydiver a time  $t$  seconds,  $t \geq 0$ . After her parachute opens, her velocity satisfies the differential equation  $\frac{dv}{dt} = -2v - 32$ , with initial condition  $v(0) = -50$ .

a. Use separation of variables to find an expression for  $v$  in terms of  $t$ , where  $t$  is measured in seconds.

b. Terminal velocity is defined as  $\lim_{t \rightarrow \infty} v(t)$ . Find the terminal velocity of the skydiver to the nearest foot per second.

c. It is safe to land when her speed is 20 feet per second. At what time  $t$  does she reach this speed?



The amount of water in a storage tank, in gallons, is modeled by a continuous function on the time interval  $0 \leq t \leq 7$ , where  $t$  is measured in hours. In this model, rates are given as follows:

- (i) The rate at which water enters the tank is  $f(t) = 100t^2 \sin(\sqrt{t})$  gallons per hour for  $0 \leq t \leq 7$ .
- (ii) The rate at which water leaves the tank is  $g(t) = \begin{cases} 250 & \text{for } 0 \leq t < 3 \\ 2000 & \text{for } 3 < t \leq 7 \end{cases}$  gallons per hour.

The graphs of  $f$  and  $g$ , which intersect at  $t = 1.617$  and  $t = 5.076$ , are shown in the figure above. At time  $t = 0$ , the amount of water in the tank is 5000 gallons.

a. How many gallons of water enter the tank during the time interval  $0 \leq t \leq 7$ ? Round your answer to the nearest gallon.

b. For  $0 \leq t \leq 7$ , find the time intervals during which the amount of water in the tank is decreasing. Give a reason for each answer.

c. For  $0 \leq t \leq 7$ , at what time  $t$  is the amount of water in the tank greatest? To the nearest gallon, compute the amount of water at this time. Justify your answer.