

19. In this solution, we make use of the notation  $x(t)$  for the value of  $x$  at a particular  $t$ . Thus,  $x(t) = 50t + 10t^2$  with SI units (meters and seconds) understood.

(a) The average velocity during the first 3 s is given by

$$v_{\text{avg}} = \frac{x(3) - x(0)}{\Delta t} = \frac{(50)(3) + (10)(3)^2 - 0}{3} = 80 \text{ m/s} .$$

(b) The instantaneous velocity at time  $t$  is given by  $v = dx/dt = 50 + 20t$ , in SI units. At  $t = 3.0$  s,  $v = 50 + (20)(3.0) = 110$  m/s.

(c) The instantaneous acceleration at time  $t$  is given by  $a = dv/dt = 20 \text{ m/s}^2$ . It is constant, so the acceleration at any time is  $20 \text{ m/s}^2$ .

(d) and (e) The graphs below show the coordinate  $x$  and velocity  $v$  as functions of time, with SI units understood. The dotted line marked (a) in the first graph runs from  $t = 0$ ,  $x = 0$  to  $t = 3.0$  s,  $x = 240$  m. Its slope is the average velocity during the first 3 s of motion. The dotted line marked (b) is tangent to the  $x$  curve at  $t = 3.0$  s. Its slope is the instantaneous velocity at  $t = 3.0$  s.

