2-22

Given $\{ \cdot \ x = bt + ct^3$ $\quad b = 1.50\ m/s$, $c = .640\ m/s^3$ [redacted]

Let's explicitly note that x is a function of time

$x(t) = b\cdot t + ct^3$

Know • Definition of average velocity (Eq 2-1): $\bar{v} = \frac{\Delta x}{\Delta t}$

$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x(t_2) - x(t_1)}{t_2 - t_1}$

(a) over interval from 1.00s to 3.00s

$t_1 = 1.00s \rightarrow x(t_1) = x(1) = (1.50\frac{m}{s})\cdot(1.00s) + (.640\frac{m}{s^3})\cdot(1.00s)^3$

~~$t_2 = 3.00s$~~ $\quad x(t_1) = 2.14m$

$t_2 = 3.00s \rightarrow x(t_2) = x(3.00) = (1.50\frac{m}{s})(3.00s) + (.640\frac{m}{s^3})(3.00s)^3$

$x(t_2) = 21.78m$

$\bar{v}_a = \frac{21.78m - 2.14m}{3.00s - 1.00s} = 9.82\frac{m}{s}$ $\quad \boxed{\bar{v}_a = 9.82\frac{m}{s}}$

(b) $\bar{v}_b = \frac{x(t_2) - x(t_1)}{t_2 - t_1} = \frac{x(2.5s) - x(1.5s)}{2.5s - 1.5s} = \frac{13.75m - 4.41m}{1.0s} = 9.34\frac{m}{s}$

$\boxed{\bar{v}_b = 9.34\frac{m}{s}}$

(c) $\bar{v}_c = \frac{x(2.05) - x(1.95)}{2.05s - 1.95s} = 9.18\frac{m}{s}$ $\quad \boxed{\bar{v}_c = 9.18\frac{m}{s}}$

(d) $x(t) = b\cdot t + ct^3$ $\quad$ b & c are constant

$\frac{dx(t)}{dt} = b + 3\cdot c\cdot t^2$ $\quad \Leftarrow$ speed

$\cdot \frac{dx}{dt} = v(t)$ $\quad v(2.00s) = b + 3\cdot c\cdot(2.00s)^2 = 1.50\frac{m}{s} + 3\cdot .640\frac{m}{s^3}\cdot 4s^2$

$\boxed{v(2.00s) = 9.18\ m/s}$

As the interval surrounding 2s gets smaller, the values for average velocity and instantaneous velocity become closer. The values in (c) & (d) differ by less than .02%