*The displacement (in centimeters) of a particle moving back and forth along a straight line is given by the equation of motion $s = 2\sin(\pi t) + 3\cos(\pi t)$, where $t$ is measured in seconds.*[1]

(a) *Find the average velocity during each time period.*

We will use the TI-84 for calculation. The units on the average velocity will be $\frac{\text{cm}}{\text{sec}}$.

(i) [1,2]

$$\begin{aligned}\text{ave. vel.} &= \frac{s(2) - s(1)}{2 - 1} \\ &= 6\,\frac{\text{cm}}{\text{sec}}\end{aligned}$$

(ii) [1,1.1]

$$\begin{aligned}\text{ave. vel.} &= \frac{s(1.1) - s(1)}{1.1 - 1} \\ &\approx -4.7120\,\frac{\text{cm}}{\text{sec}}\end{aligned}$$

(iii) [1,1.01]

$$\begin{aligned}\text{ave. vel.} &= \frac{s(1.01) - s(1)}{1.01 - 1} \\ &\approx -6.1341\,\frac{\text{cm}}{\text{sec}}\end{aligned}$$

(iv) [1,1.001]

$$\begin{aligned}\text{ave. vel.} &= \frac{s(1.001) - s(1)}{1.001 - 1} \\ &\approx -6.2684\,\frac{\text{cm}}{\text{sec}}\end{aligned}$$

(b) *Estimate the instantaneous velocity of the particle when $t = 1$.*

Let's do one more calculation of average velocity over the interval [1,1.0001].

$$\begin{aligned}\text{ave. vel.} &= \frac{s(1.0001) - s(1)}{1.0001 - 1} \\ &\approx -6.2817\,\frac{\text{cm}}{\text{sec}}\end{aligned}$$

This, together with the computations form part (a), lead us to estimate the instantaneous velocity at $t = 1$ to be $\approx -2\pi\,\frac{\text{cm}}{\text{sec}}$.

[1] Stewart, *Calculus, Early Transcendentals*, p. 82, #8.