p. 137 (19) A particle moves along a line so that its position at any time $t \geq 0$ is given by the function $s(t) = t^2 - 3t + 2$ where s is measured in meters and t is measured in seconds.

Displacement
- change in y
- change in position

a) Find the displacement during the first 5 seconds.

$s(0) = 2$

$s(5) = 12$

$\Delta y = 12 - 2 = 10$ meters

$s(5) - s(0)$

b) Find the average velocity during the first 5 seconds.

$$\text{slope} = \frac{\Delta y}{\Delta x} = \frac{12-2}{5-0} = \frac{10}{5} = 2 \text{ m/sec}$$

c) Find the instantaneous velocity when t = 4.

$s(t) = t^2 - 3t + 2$

$v(t) = 2t - 3$

$v(4) = 2(4) - 3 = 5$ m/sec

d) Find the acceleration of the particle when t = 4.

$s(t) = t^2 - 3t + 2$

$v(t) = 2t - 3$

$a(t) = 2$

e) At what values of t does the particle change direction?

$v(t) = 0$

$2t - 3 = 0$

$t = \frac{3}{2}$

$v(t) < 0$ Down or Left

$v(t) > 0$ Up or Right

f) Describe the particles motion

$v(t) = 2t - 3$

$v(1) = 2(1) - 3 = -1 < 0$

s(t) Down or Left

Left if $t = \frac{3}{2}$

Right if $t = \frac{3}{2}$

$v(2) = 2(2) - 3 = 1 > 0$

s(t) up or right

a) Find the body's velocity, speed, and acceleration at time t.

b) Find the the body's velocity, speed, and acceleration at time $t = \frac{\pi}{4}$

15. $s(t) = 2\sin t + 3\cos t$

$v(t) = 2\cos t - 3\sin t$

$v\left(\frac{\pi}{4}\right) = 2\cos\frac{\pi}{4} - 3\sin\frac{\pi}{4} = 2\left(\frac{\sqrt{2}}{2}\right) - \frac{3\sqrt{2}}{2}$

$= \sqrt{2} - \frac{3\sqrt{2}}{2} = -.707$

How Fast ← $\text{speed} = |v(t)| = \left|v\left(\frac{\pi}{4}\right)\right| = \left|\sqrt{2} - \frac{3\sqrt{2}}{2}\right| = .707$

$a(t) = -2\sin t - 3\cos t$

$a\left(\frac{\pi}{4}\right) = -2\sin\frac{\pi}{4} - 3\cos\frac{\pi}{4} = -2\left(\frac{\sqrt{2}}{2}\right) - \frac{3\sqrt{2}}{2}$

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(24) Find the speed when acceleration is zero.

$v(t) = 2t^3 - 9t^2 + 12t - 5$

$a(t) = 6t^2 - 18t + 12$

$0 = 6(t^2 - 3t + 2)$

$0 = 6(t-2)(t-1)$

$t = 2 \quad t = 1$

$\text{speed} = |v(1)| = 0$

$\text{speed} = |v(2)| = |-1| = 1$