

Particle Motion

Answer the following questions for each position function $s(t)$ in meters where t is in second if a particle is moving along the x-axis.

$s(t) = t^3 - 3t + 3$ [0,6]

a. What is the velocity function?
 $v(t) = 3t^2 - 3$

b. What is the velocity at $t = 3$ seconds?
 $v(3) = 3(3)^2 - 3 = 24 \text{ m/s}$

c. When is the particle at rest?
 $0 = 3t^2 - 3$
 $0 = 3(t^2 - 1)$
 $(t+1)(t-1)$ $t = 1 \text{ sec}$

d. When is the particle moving right? Moving left?

 left: (0, 1) right: (1, 6)

e. What is the acceleration function?
 $a(t) = 6t$

f. What is the acceleration at $t = 1$ second?
 $a(1) = 6(1) = 6 \text{ m/s}^2$

g. What is the displacement?
 $s(0) = 3$ $s(6) = 201$
 $201 - 3 = 198 \text{ m}$

h. What is the total distance traveled?
 $(0, 1)$ $s(0) = 3$ $s(1) = 1 = |1 - 3| = 2 \text{ m}$
 $(1, 6)$ $s(1) = 1$ $s(6) = 201 = 200 \text{ m}$
 $200 + 2 = 202 \text{ m}$

i. When is the particle speeding up? Slowing Down?
 $a(t) = 6t$ $6t = 0$ $t = 0$

 $v(t)$ $\frac{- - 0 + +}{0 \quad 1 \quad 6}$ slow \downarrow (0, 1)
 $a(t)$ $\frac{+ + + +}{0 \quad 1 \quad 6}$ speed \uparrow (1, 6)

j. Find the velocity when the acceleration is 0.
 $a(t) = 6t$ $v(t) = 3t^2 - 3$
 $0 = 6t$ $3(0)^2 - 3$
 $0 = t$ $= -3 \text{ m/s}$

$s(t) = t^3 - 6t^2$ [0,7]

a. What is the velocity function?
 $v(t) = 3t^2 - 12t$

b. What is the velocity at $t = 3$ seconds?
 $v(3) = 3(3)^2 - 12(3) = -9 \text{ m/s}$

c. When is the particle at rest?
 $0 = 3t^2 - 12t$
 $0 = 3t(t - 4)$
 $t = 0 \text{ sec}$ $t = 4 \text{ sec}$

d. When is the particle moving right? Moving left?

 right (4, 7)
 left (0, 4)

e. What is the acceleration function?
 $a(t) = 6t - 12$

f. What is the acceleration at $t = 1$ second?
 $a(1) = 6(1) - 12$
 $a(1) = -6 \text{ m/s}^2$

g. What is the displacement?
 $s(0) = 0$ $s(7) = 49$
 49 m

h. What is the total distance traveled?
 $s(4) = -32 \text{ m}$
 $(0, 4) = |-32 - 0| = 32 \text{ m}$ $s(7) = 49$
 $(4, 7) = |49 - (-32)| = 81 \text{ m}$
 $32 + 81 = 113 \text{ m}$

i. When is the particle speeding up? Slowing Down?

 $v(t) = \frac{- - 0 + +}{0 \quad 4 \quad 7}$ speed \uparrow (0, 2) (4, 7)
 $a(t) = \frac{- + + +}{0 \quad 2 \quad 7}$ slow \downarrow (2, 4)

j. Find the velocity when the acceleration is 0.
 $0 = 6t - 12$ $v(t) = 3t^2 - 12t$
 $12 = 6t$ $v(2) = 3(2)^2 - 12(2)$
 $t = 2$ $= -12 \text{ m/s}$

$$s(t) = 2t^3 - 21t^2 + 60t + 3 \quad [0,8]$$

a. What is the velocity function?

$$v(t) = 6t^2 - 42t + 60$$

b. What is the velocity at $t = 3$ seconds?

$$v(3) = 6(3)^2 - 42(3) + 60$$

$$v(3) = -12 \text{ m/s}$$

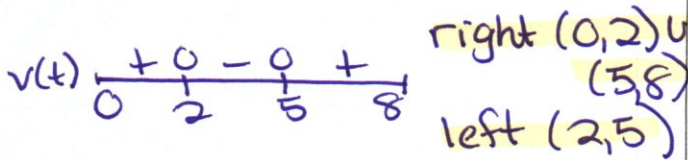
c. When is the particle at rest?

$$0 = 6t^2 - 42t + 60$$

$$0 = 6(t^2 - 7t + 10) \quad t = 5 \text{ sec}$$

$$0 = 6(t-5)(t-2) \quad t = 2 \text{ sec}$$

d. When is the particle moving right? Moving left?



e. What is the acceleration function?

$$a(t) = 12t - 42 \quad a(0) = -42$$

f. What is the acceleration at $t = 1$ second?

$$a(1) = 12(1) - 42 = -30 \text{ m/s}^2$$

g. What is the displacement?

$$s(0) = 3 \quad s(8) = 163$$

$$163 - 3 = 160 \text{ m}$$

h. What is the total distance traveled?

$$(0, 2) = |55 - 3| = 52 \quad s(2) = 55$$

$$(2, 5) = |55 - 28| = 27 \quad s(5) = 28$$

$$(5, 8) = |163 - 28| = 135 \quad 214 \text{ m}$$

i. When is the particle speeding up? Slowing Down?



j. Find the velocity when the acceleration is 0.

$$0 = 12t - 42 \quad v(7/2) = 6(7/2)^2 - 42(7/2) + 60$$

$$= -13.5 \text{ m/sec}$$

$$\frac{42}{12} = 12t$$

$$\frac{7}{2} = t$$

$$s(t) = 2t^3 - 14t^2 + 22t - 5 \quad [0,6]$$

a. What is the velocity function?

$$v(t) = 6t^2 - 28t + 22$$

b. What is the velocity at $t = 3$ seconds?

$$v(3) = -8 \text{ m/s}$$

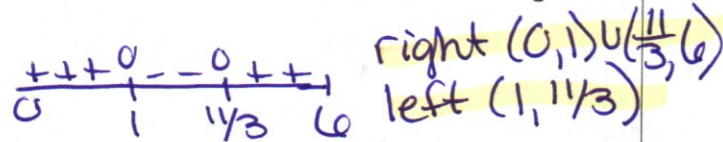
c. When is the particle at rest?

$$0 = 6t^2 - 28t + 22 \quad t = 1 \text{ sec}$$

$$0 = 2(3t^2 - 14t + 11) \quad t = \frac{11}{3} \text{ sec}$$

$$(3t-11)(t-1)$$

d. When is the particle moving right? Moving left?



e. What is the acceleration function?

$$a(t) = 12t - 28$$

For part i:
 $0 = 12t - 28$
 $\frac{28}{12} = t = \frac{7}{3}$

f. What is the acceleration at $t = 1$ second?

$$a(1) = 12(1) - 28 = -16 \text{ m/s}^2$$

g. What is the displacement?

$$s(0) = -5 \quad s(6) = 55$$

$$55 - (-5) = 60 \text{ m}$$

h. What is the total distance traveled?

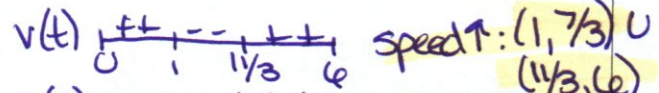
$$s(1) = 5 \quad s(11/3) = -13.96 \quad s(6) = 55$$

$$(0, 1) = |5 - (-5)| = 10$$

$$(1, 11/3) = |-13.96 - 5| = 18.96 \quad 17.92 \text{ m}$$

$$(11/3, 6) = |55 - (-13.96)| = 68.96$$

i. When is the particle speeding up? Slowing Down?



j. Find the velocity when the acceleration is 0.

$$0 = 12t - 28 \quad v(7/3) = -\frac{32}{3} \text{ m/s}$$

$$\text{or } -10.67 \text{ m/s}$$