

# Position, Velocity, and Acceleration

# Position, Velocity, Acceleration

1.  $x(t) = t^3 - 3t^2 - 24t + 10, \quad t = 0, 5$

$$v(t) = 3t^2 - 6t - 24$$

$$a(t) = 6t - 6$$

$$x(0) = 10$$

$$x(5) = -60$$

$$v(0) = -24$$

$$v(5) = 21$$

$$a(0) = -6$$

$$a(5) = 24$$

Resting Position

$$0 = 3t^2 - 6t - 24$$

$$0 = t^2 - 2t - 8$$

$$0 = (t - 4)(t + 2)$$

$$t = 4$$

# Position, Velocity, Acceleration

1.  $x(t) = t^3 - 3t^2 - 24t + 10, \quad t = 0, 5$

Displacement

$$x(5) - x(0) = \boxed{-70}$$

Total Distance

$$\int_0^4 \left| (3t^2 - 6t - 24) \right| dt + \int_4^5 \left| (3t^2 - 6t - 24) \right| dt$$

$$\left| t^3 - 3t^2 - 24t \right|_0^4 + \left| t^3 - 3t^2 - 24t \right|_4^5$$

$$\left| (64 - 48 - 96) - (0) \right| + \left| (125 - 75 - 120) - (64 - 48 - 96) \right|$$

$$80 + 10 = \boxed{90}$$

# Position, Velocity, Acceleration

2.  $x(t) = 6t + 3\cos(t) + 5, \quad t = 0, \pi$

$$v(t) = 6 - 3\sin t$$

$$0 = 6 - 3\sin t$$

$$2 = \sin t$$

$t =$  No Solutions

Displacement

$$\int_0^{\pi} (6 - 3\sin t) dt =$$

$$6t + 3\cos t \Big|_0^{\pi} =$$

$$(6\pi - 3) - (0 + 3) =$$

$$6\pi - 6 \approx 12.849$$

Total Distance

$$\int_0^{\pi} |6 - 3\sin t| dt$$

$$\left| 6t + 3\cos t \Big|_0^{\pi} \right|$$

$$\left| (6\pi - 3) - (3) \right|$$

$$6\pi - 6 \approx 12.849$$

# Position, Velocity, Acceleration

3.  $x(t) = -2t^3 - 3t^2 + 36t + 10, \quad t = 0, 2$

$$v(t) = -6t^2 - 6t + 36$$

$$0 = -6t^2 - 6t + 36$$

$$t = -2, 3$$

Displacement

$$\int_0^2 (-6t^2 - 6t + 36) dt$$

$$\left(-2t^3 - 3t^2 + 36t\right) \Big|_0^2$$

$$(-16 - 12 + 72) - (0)$$

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Total Distance

$$\int_0^2 \left| -6t^2 - 6t + 36 \right| dt$$

$$\left| -2t^3 - 3t^2 + 36t \right|_0^2$$

$$\left| (-16 - 12 + 72) - (0) \right|$$

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# Position, Velocity, Acceleration

4.  $v(t) = 3t^2 - 12t - 15, \quad x(0) = 12$

$$x(t) = t^3 - 6t^2 - 15t + 12$$

$$a(t) = 6t - 12$$

Resting Position

$$0 = 3t^2 - 12t - 15$$

$$0 = t^2 - 4t - 5$$

$$0 = (t - 5)(t + 1)$$

$$t = 5$$

$$v(a(t) = 0)$$

$$0 = 6t - 12$$

$$v(2) = -27$$

$$x(5)$$

$$x(5) = -88$$