CONCEPT: CALCULATING AVERAGE AND INSTANTANEOUS VELOCITY FROM THE POSITION FUNCTION

- Some problems will ask for the average and instantaneous velocity when given a position function _____.
  - Position function: an equation that gives you an object's position for any value of _____.

EXAMPLE: The position of a ball is $x(t) = t^2 + 4$.

a) Calculate the object's position at t = 3s.

b) Calculate the ball's velocity between t = 3 and t = 5.

c) Calculate the ball's velocity at t = 5.

AVERAGE VELOCITY

→ between *TWO* points t_0 & t_f

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_0}{\Delta t} = \text{\_\_\_\_\_}$$

INSTANTANEOUS VELOCITY

→ at *ONE* point (instant) t

$$v(t) = \text{—} \qquad = \text{———}$$

- To get $v(t)$, take the _____ of $x(t)$

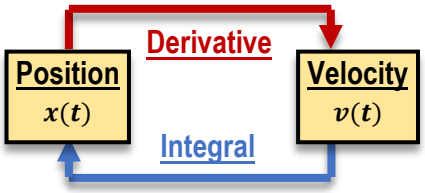
Derivatives:

1) $\frac{d}{dt}(Ct^N) = N * C\, t^{N-1}$

2) $\frac{d}{dt}(\text{constant}) = 0$

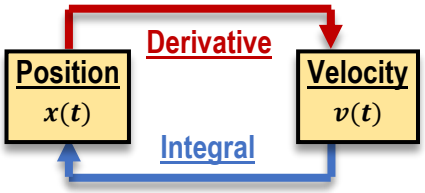
PROBLEM: The position function for a particle moving on the x-axis is $x(t) = -2t^2 + 18t + 7$. What is the particle's initial velocity?

A) v_0 = 18 m/s
B) v_0 = 7 m/s
C) v_0 = 9 m/s
D) v_0 = 4.5 m/s



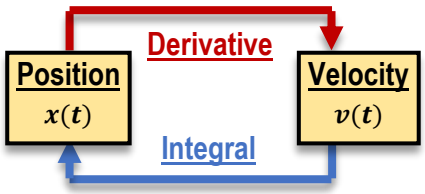
PROBLEM: The position function for a particle moving on the x-axis is $x(t) = -3t^2 + 12t - 2.6$. What is the particle's position at the moment where it comes to a stop?

A) x = –2.6 m
B) x = 33.4 m
C) x = 12 m
D) x = 9.4 m



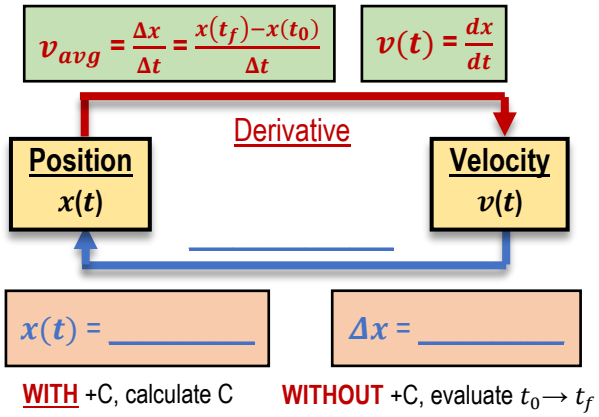
PROBLEM: The position of a small object is given by $x = 0.6e^{2t} - 1$, where t is in seconds and x in meters. At what time is the small object travelling with a velocity v = 65.5m/s?

A) 2.35 s
B) 2.0 s
C) 2.69 s
D) Never



CONCEPT: CALCULATING POSITION AND DISPLACEMENT FROM VELOCITY FUNCTIONS

- Some problems will GIVE the velocity function $\boldsymbol{v(t)}$ and ASK for the position function $\boldsymbol{x(t)}$ or displacement $\boldsymbol{\Delta x}$.
  - To calculate *position or displacement* from *velocity* functions, do the _____ of a derivative.



EXAMPLE: An object's position function **x(t)** = $2t^2$ + 5. Determine the velocity function **v(t).**

EXAMPLE: An object's velocity function **v(t)** = 4t.
a) At t = 0, the object's position is x = 5. Determine **x(t).**

Position Function $x(t)$ ⇐ Velocity $v(t)$

→ at *ONE* point t

$x(t)$ = _____

- **Remember** to add an integration constant **+C!**
  - To calculate C, plug given initial conditions from problem text into $\boldsymbol{x(t)}$

Integrals:

$$\int t^N dt = \frac{t^{N+1}}{N+1}$$

b) Calculate $\boldsymbol{\Delta x}$ from 1 to 4s.

Displacement Δx ⇐ Velocity $v(t)$

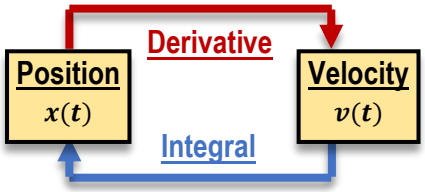
→ between *TWO* points t_0 & t_f

$\Delta x = x_f - x_0$ = _____

- **NO** integration constant **+C!**

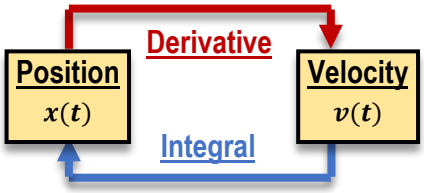
PROBLEM: A ball's velocity is given by $v(t) = \frac{1}{2}t^3 - 2t$. Calculate the ball's displacement from t = 1.5s to t = 3s.

A) 8.81 m
B) 2.74 m
C) 35.0m
D) –2.74 m



PROBLEM: An object's velocity is given by the equation $v(t) = cos(t) - 3t^2$. At t = 2 the object's position is x = 10. What is the object's position at t = 1.4s?

A) x = 16.7 m
B) x = 15.8 m
C) x = 15.3 m
D) x = 19.3 m



Reminder! When working with trigonometry functions, put calculator in ***RADIANS*** mode!