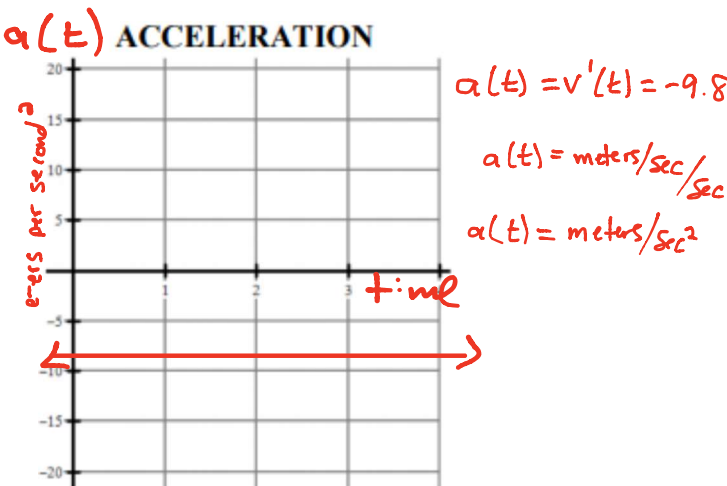
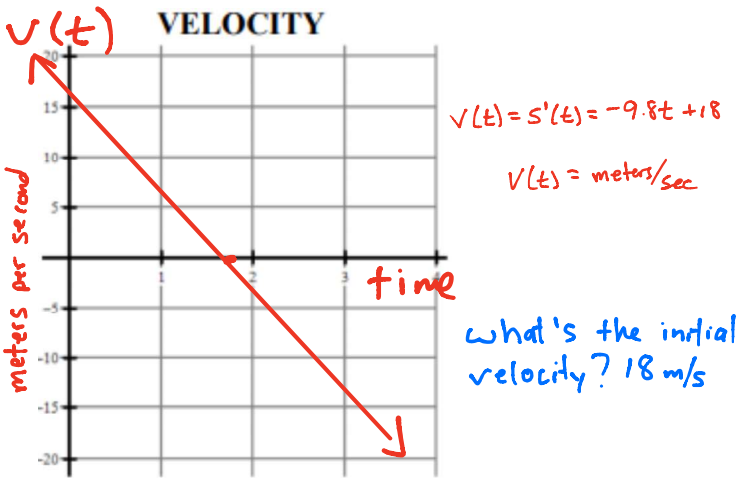
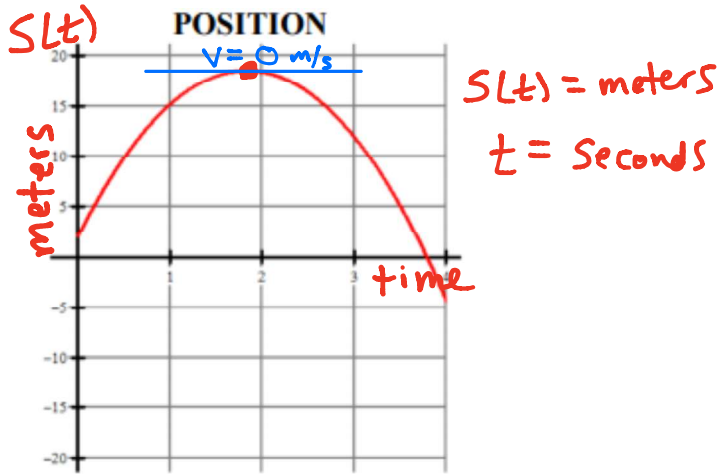


Velocity, Speed, and Acceleration

Mr Bean is playing catch with his best friend, himself. He throws a tennis ball straight up into the air. The height of the ball is modeled by $s(t) = -4.9t^2 + 18t + 2$ where t is time in seconds and s is the height of the ball from the ground in meters



$Speed = |velocity|$

Particle Motion

The position (x -coordinate) of a particle moving on the x -axis is by $x(t) = t^3 - 4t^2 + 3$ for $t \geq 0$.

Find the displacement of the particle during the first 2 seconds.

$$x(2) = (2)^3 - 4(2)^2 + 3 = 8 - 4(4) + 3 = 8 - 16 + 3 = -5$$

$$x(0) = (0)^3 - 4(0)^2 + 3 = 0 - 0 + 3 = 3$$

Displacement = $-5 - 3 = -8$

Find the average velocity of the particle during the first 4 seconds.

$$AV = \frac{x(b) - x(a)}{b - a} = \frac{x(4) - x(0)}{4 - 0} = \frac{(-5) - (3)}{4} = \frac{-8}{4} = -2$$

$AV = -2 \text{ units/sec}$

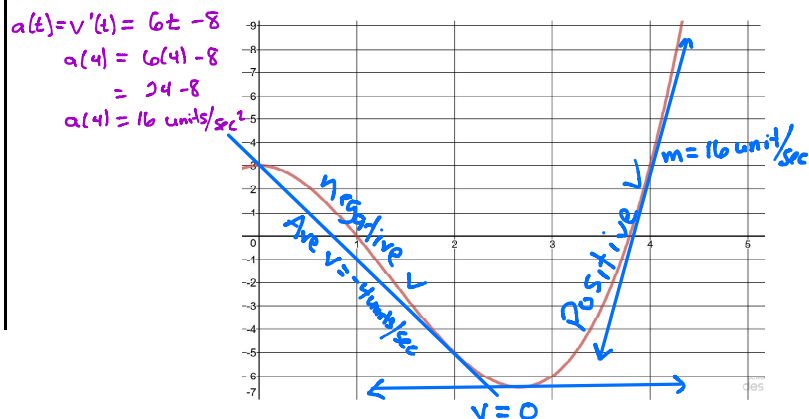
Find the instantaneous velocity of the particle when $t = 4$.

$v(t) = x'(t) = 3t^2 - 8t$

$$v'(4) = 3(4)^2 - 8(4) = 3(16) - 32 = 48 - 32 = 16$$

$v'(4) = 16 \text{ units/sec}$

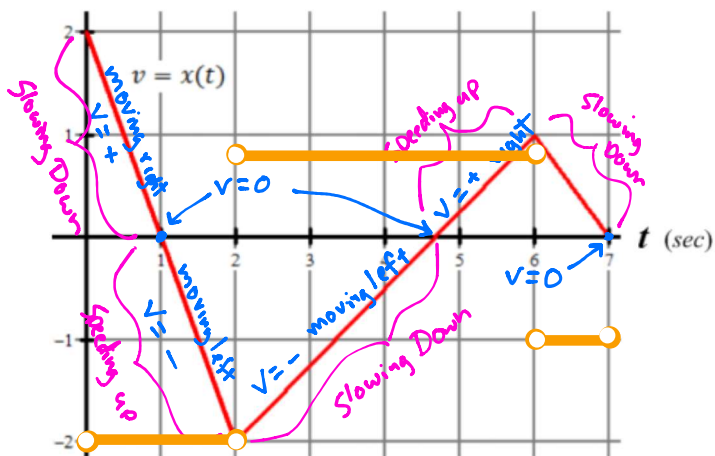
Find the acceleration of the particle when $t = 4$. Describe the motion of the particle.



3.3 Velocity and Other Rates of Change

Particle Motion

The figure shows the velocity $v = x'(t)$ of a particle moving on a coordinate line.



When does the particle move right? Move left? Speed up? Slow down?

Right: $(0, 1) \cup (4.75, 6)$ Speed up: $(1, 2) \cup (4.75, 6)$

Left: $(1, 4.75)$ Slow down: $(0, 1) \cup (2, 4)$

When is the particle's acceleration Positive? Negative? Zero?

Positive: $(2, 6)$
 Negative: $(0, 2) \cup (6, 7)$
 Zero: $2, 6$

When does the particle have the greatest speed?

At 0 and 7 seconds

= |velocity|

Verbally and Algebraically

The area of circle whose radius is measured in inches.

$$A(4) = \pi(4)^2 = 16\pi \text{ in}^2$$

when the radius is 4 inches, the area is $16\pi \text{ in}^2$

$$\frac{dA}{dr} \Big|_{r=4} = 2\pi(4) = 8\pi \text{ in}^2/\text{in}$$

when the radius is 4 inches, the area is growing by $8\pi \text{ in}^2$ per inch

Average rate of change from 3 to 5

$$A = \pi r^2$$

$$ARC = \frac{A(5) - A(3)}{(5) - (3)}$$

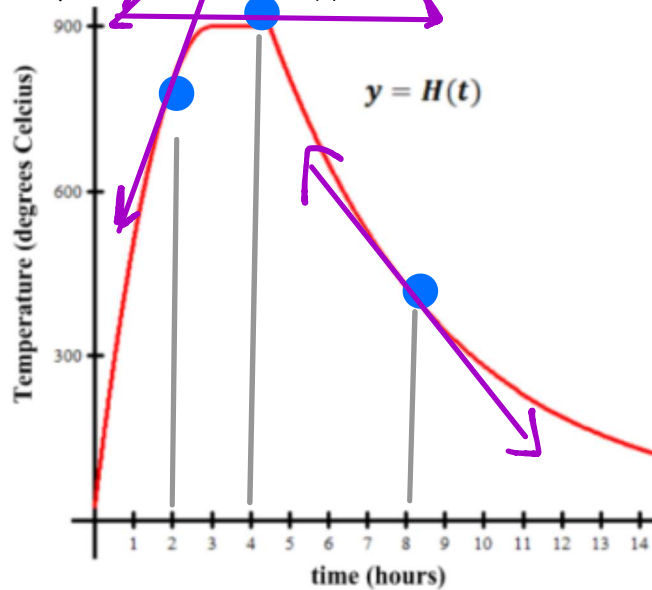
$$= \frac{25\pi - 9\pi}{2}$$

$$ARC = \frac{16\pi}{2} = 8\pi$$

$$A' = 2\pi r$$

Graphically

Temperature of a kiln $y = H(t)$



Tangent

Compare these slopes

$H'(2) = \text{positive}$

$H'(4) = 0$

$H'(8) = \text{negative}$

Average rate of change 0 to 3

$$= \frac{900 - 30}{3 - 0} = \frac{870}{3}$$

Calculators Produced (in hundreds)	6	7.5	8	10	11	12
Profit (in thousands of dollars)	14	12.8	11	13.2	14.2	15.3

Approximate $P'(9)$

$$ARC = \frac{P(10) - P(8)}{10 - 8}$$

$$= \frac{13.2 - 11}{10 - 8}$$

$$= \frac{2.2}{2}$$

$$= \$1.1/\text{hour hand sales.}$$