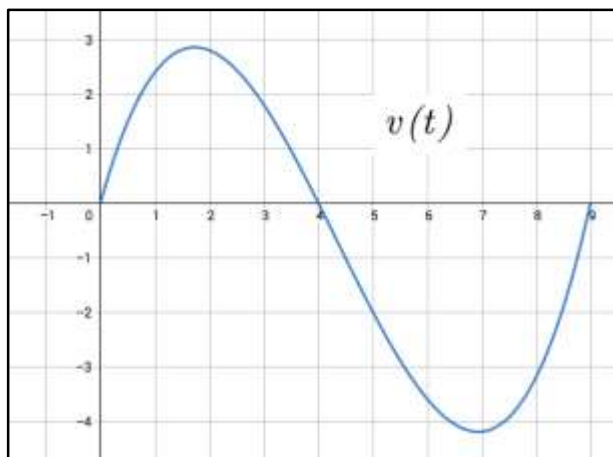


Directions: In the box below are the numbers 0 – 9. Complete the following problems and cross off the number for each answer. If you complete all problems correctly, you will cross off each number exactly once!

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

a) A particle moves along the x axis for $t \geq 0$. The position of the particle is given by $x(t) = t^3 - 9t^2 - 21t + 6$. At what time t does the particle change directions?

b) A bug is moving back and forth on a straight path. The velocity of the bug is given by $v(t) = t^2 - 3t$. Find the average acceleration of the bug over the interval $[1, 4]$.



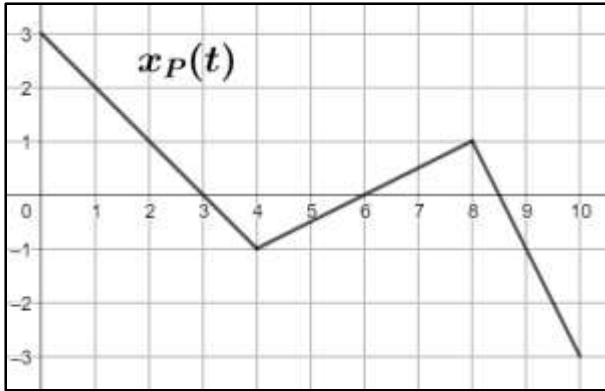
c) The velocity of a particle for $0 \leq t \leq 9$ is given in the graph above. At which of the following values of t is the particle speeding up?

$t = 3$

$t = 4$

$t = 5$

$t = 7$



t	1	3	7	9
$x_Q(t)$	4	1	-1	-2
$v_Q(t)$	3	0	-2	3
$a_Q(t)$	-1	-2	4	1

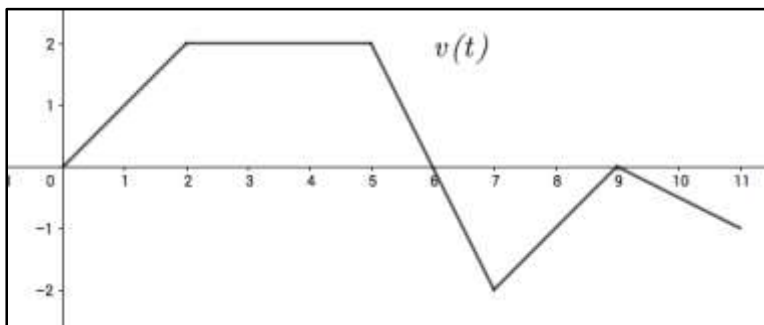
- d) For $0 \leq t \leq 10$, particles P and Q move along the x axis. The position of particle P can be modeled by $x_P(t)$ as shown in the figure above. The position of particle Q is defined by $x_Q(t)$. Selected values of $x_Q(t)$, $v_Q(t)$, and $a_Q(t)$ are given in the table above. At what time t are particles P and Q moving towards each other?

- e) The position of a bug moving up and down a vertical post is given by the equation

$$y(t) = \frac{-12}{\pi} \cos\left(\frac{\pi t}{6}\right) + 6t - 1. \text{ Find } v(3).$$

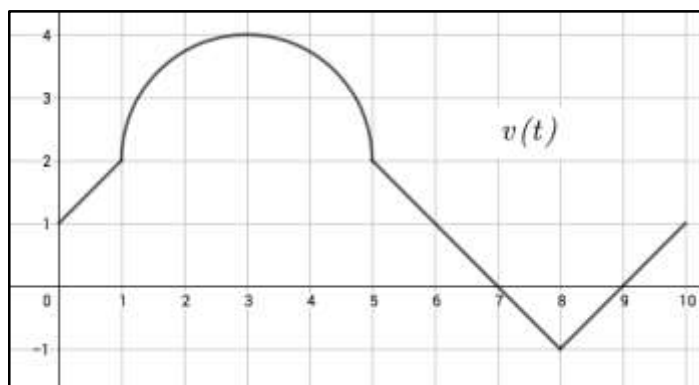
t	1	2	4	6	8
$x(t)$	3	0	-1	-4	5
$v(t)$	2	1	-3	3	0

- f) A particle is moving along the x axis. The position and velocity of the particle is recorded for various times in the table above. At which time t is the particle moving towards the origin?



g) The velocity of a particle is given in the graph above for $0 \leq t \leq 11$. How many times on the interval does the particle change directions?

h) The position of a bug moving along a straight path is given by $s(t) = t^2 - 2t + 3$. At what time t is the instantaneous velocity equal to the average velocity of the bug on $[0, 6]$?



i) The velocity of an object is graphed above for $0 \leq t \leq 10$. What is the velocity of the object when the acceleration equals 0?

j) The position of a bug moving along the x axis is given by $x(t) = at + b$, where a and b are both nonzero. Find the acceleration of the bug at any given time t .