Calculus

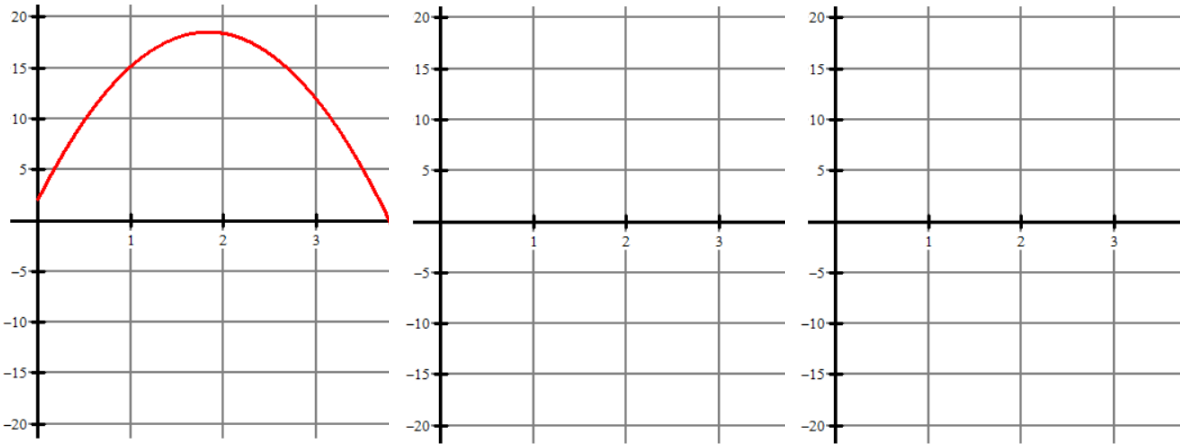
Write your questions and thoughts here!

4.2 Position, Velocity, and Acceleration

Notes

Mr. Brust 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 $\boldsymbol{s(t) = -4.9t^2 + 18t + 2}$ where t is time in seconds and s is the height of the ball from the ground in meters.

POSITION **VELOCITY** **ACCELERATION**



Position function: $s(t)$

Velocity function: $v(t) =$

Acceleration function: $a(t) =$

Velocity = Rate of Change of Position

$v(t) < 0$ means the particle is _____

$v(t) > 0$ means the particle is _____

$v(t) = 0$ means the particle is _____

Average velocity =

Speed =

Speeding Up or Slowing Down?

If velocity and acceleration have the **same** sign, the particle is _____

If velocity and acceleration have **different** signs, the particle is _____

t	-5	1	2	4
$v(t)$	3	-2	1	-1
$a(t)$	-4	7	0.1	-1
Conclusion				

Displacement:

Write your questions and thoughts here!

Particle Motion from an equation.

The position (x-coordinate) of a particle moving on the x-axis is modeled by the function

$$x(t) = t^3 - 4t^2 + 3 \text{ for } t \geq 0,$$

Where x is measured in cm and t is measured in minutes.

1. Find the displacement of the particle during the first 2 minutes.

2. Find the average velocity of the particle during the first 2 minutes.

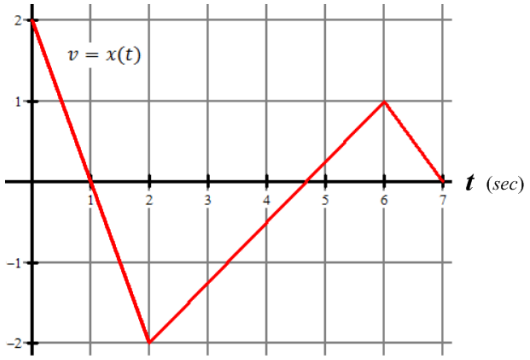
3. Find the velocity of the particle when $t = 4$.

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

5. Is the particle speeding up or slowing down at $t = 4$? Justify.

Particle Motion from a graph

The figure shows the velocity $v = x(t)$ of a particle moving on a coordinate line.



6. When is the particle moving right? Justify.

7. When is the particle moving left? Justify.

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

9. When does the particle have the greatest speed?

10. When is the particle speeding up? Justify.

11. When is the particle slowing down? Justify.

4.2 Position, Velocity, and Acceleration

Calculus

Practice

1. A particle moves along a line so that its position at any time $t \geq 0$ is given by the function

$$s(t) = \frac{1}{3}t^3 - 3t^2 + 8t - 5$$

where *s* is measured in meters and *t* is measured in seconds.

a. Find the instantaneous velocity at any time *t*.

b. When is the particle at rest?

c. Find the acceleration of the particle at any time *t*.

d. What is the displacement of the particle for the first 3 seconds?

2. A ball is dropped off a 1200 ft cliff. The height of the ball over time is modeled by the function $h(t) = 1200 - 16t^2$ where h is the height of the ball and t is time in seconds.

a. Find $h'(3)$. Explain what it means.

b. Find $h''(3)$. Explain what it means.

3. The position, in meters, of a body at time *t* sec is $s(t) = t^3 - 6t^2 + 9t$. Find the body's acceleration each time the velocity is zero.

4. A particle *P* moves on the number line. The graph $s = f(t)$ shows the position of *P* as a function of time *t*.

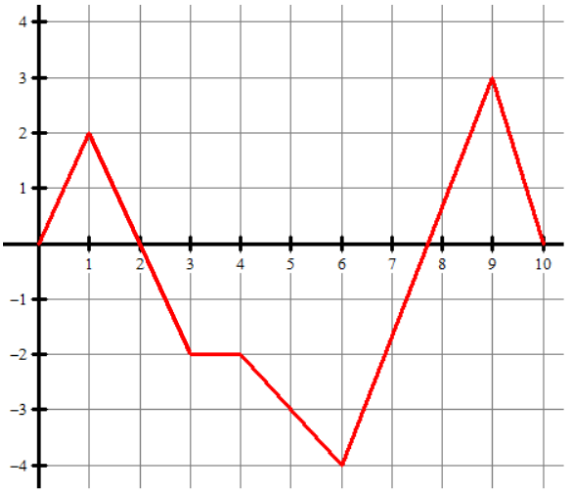
a. When is *P* moving to the left?

b. When is *P* moving to the right?

c. When is *P* at rest?

d. Graph the particle's velocity where defined.

5. The figure shows the velocity $v = \frac{ds}{dt} = f(t)$ of a body moving along a coordinate line in meters per second.



a. When does the body reverse direction?

b. When is the body moving at a constant speed?

c. What is the body's maximum speed?

d. What time interval(s) is the body speeding up?

6. A rock thrown vertically upward from the surface of the moon at a velocity of 32 meters per second reaches a height of $s(t) = 32t - 0.8t^2$ meters in t seconds.

a. Find the rock's velocity and acceleration as functions of time.

b. How long did it take the rock to reach its highest point?

7. The data in the table gives selected values for the velocity, in meters per minute, of a particle moving along the x-axis. The velocity v is a differentiable function of time t.

Time t	0	2	5	6	8	12
Velocity $v(t)$	-3	2	3	5	7	5

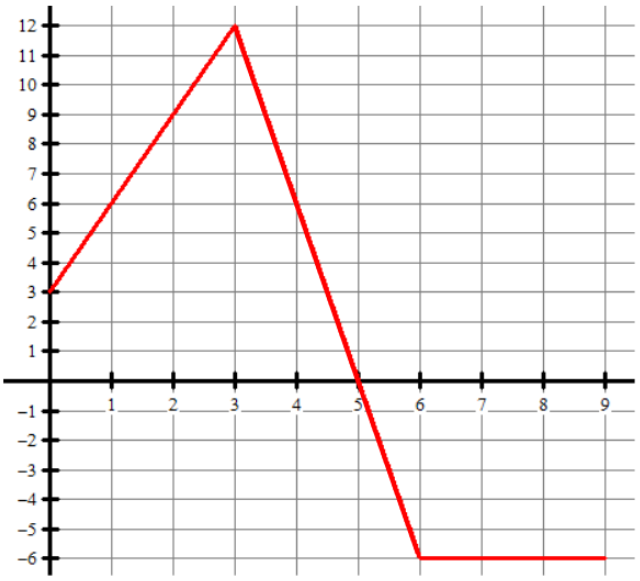
a. At $t = 0$, is the particle moving to the right or left? Justify.

b. Is there a time during the time interval $0 \le t \le 12$ minutes when the particle is at rest? Justify.

c. Use the data from the table to approximate $v'(10)$.

d. Explain the meaning of $v'(10)$ in terms of the particle motion.

8. The graph represents the velocity, in feet per second, of a particle moving along the x-axis over the time interval from $t = 0$ to $t = 9$ seconds.



a. At $t = 4$, is the particle moving to the right or left? Justify.

b. Over what time interval is the particle moving left? Justify.

c. At $t = 4$, is the acceleration positive or negative? Justify.

d. What is the average acceleration of the particle over the interval $2 \leq t \leq 4$? Show the computations and label your answer.

e. At what time t in the given interval is the particle furthest to the right. Justify.

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9. A particle moves along the x-axis so that at time t its position is given by

$$x(t) = t^3 - 6t^2 + 9t + 11$$

where t is measured in seconds and x is measured in feet.

a. At $t = 0$, is the particle moving to the right or left? Justify.

b. At $t = 1$, is the velocity of the particle increasing or decreasing? Justify.

c. What is the displacement over the first 6 seconds?

No test prep. These questions are already like exam type problems.