LESSON MAKER PRO

Motion Math Lab

Use derivatives to track velocity and acceleration.

HIGH SCHOOL · MA.912.C.3.9

MA.912.C.3.9 "Find the velocity and acceleration of a particle moving in a straight line."

NAME _____ DATE _____

FROM POSITION TO MOTION

If s(t) gives position, velocity is v(t)=s'(t), the first derivative. Acceleration is a(t)=v'(t)=s''(t), the second derivative. Differentiate again after finding velocity, then substitute a time value if one is given.

WORKED EXAMPLE

A particle has position $s(t)=8t^3-6t$, where t is in seconds. Find v(t) and a(t).

1. Differentiate position: $v(t)=24t^2-6$.
2. Differentiate velocity: $a(t)=48t$.

Answer: $v(t)=24t^2-6$ and $a(t)=48t$

PRACTICE 6 problems

1 A particle has position $s(t)=5t^2+2t$. Find v(t) and a(t).

ANSWER _____

2 A particle has position $s(t)=9-5t^2$. Find v(t) and a(t).

ANSWER _____

3 A particle has position $s(t)=t^4+5t$. Find v(t) and a(t).

ANSWER _____

4 A particle has position $s(t)=2t^2-5t+9$. Find v(4) and a(4).

ANSWER _____

5 A particle has position $s(t)=9-2t^2$. Find v(5) and a(5).

ANSWER _____

6 A particle has position s(t)=7t-2. Find v(t) and a(t).

ANSWER _____

APPLY IT Show your work

1 A robotics team programs a small cart to move along a straight test lane. Its position in meters after t seconds is $s(t)=2t^2+5t$. Find the cart's velocity and acceleration at t=4.

WORK SPACE

ANSWER _____

2 In a virtual racing game, a car's signed position in meters after t seconds is $p(t)=t^4-5t^2+7$. Find the car's velocity and acceleration at t=2.

WORK SPACE

ANSWER _____

CHALLENGE One step up

A particle has position $s(t)=t^4-10t^2+7$. Find all real times when the particle's velocity is zero. Then find the acceleration at each of those times.

WORK SPACE AND ANSWER

ANSWER KEY # Motion Math Lab

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PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	A particle has position $s(t)=5t^2+2t$. Find v(t) and a(t).	**$v(t)=10t+2$ and $a(t)=10$**
2	A particle has position $s(t)=9-5t^2$. Find v(t) and a(t).	**$v(t)=-10t$ and $a(t)=-10$**
3	A particle has position $s(t)=t^4+5t$. Find v(t) and a(t).	**$v(t)=4t^3+5$ and $a(t)=12t^2$**
4	A particle has position $s(t)=2t^2-5t+9$. Find v(4) and a(4).	**$v(4)=11$ and $a(4)=4$**
5	A particle has position $s(t)=9-2t^2$. Find v(5) and a(5).	**$v(5)=-20$ and $a(5)=-4$**
6	A particle has position $s(t)=7t-2$. Find v(t) and a(t).	**$v(t)=7$ and $a(t)=0$**

PART 2 · APPLY IT

1. **Velocity: 21 m/s; acceleration: 4 m/s²** Differentiate to get $v(t)=4t+5$ and $a(t)=4$. Evaluate the velocity at $t=4$.
2. **Velocity: 12 m/s; acceleration: 38 m/s²** Differentiate to get $v(t)=4t^3-10t$ and $a(t)=12t^2-10$. Substitute $t=2$ into both expressions.

CHALLENGE

$v(t)=4t^3-20t=4t(t^2-5)$, so velocity is zero at $t=-\sqrt{5}$, 0, and $\sqrt{5}$. The accelerations are $a(-\sqrt{5})=40$, $a(0)=-20$, and $a(\sqrt{5})=40$.

Accept equivalent algebraic forms, including factored or expanded derivatives. For the real-context problems, accept correct values with m/s and m/s^2, or clearly labeled velocity and acceleration.