

# Motion Function Mission

Use initial conditions to build velocity and position functions.

HIGH SCHOOL • MA.912.C.5.1

**MA.912.C.5.1** "Find specific antiderivatives using initial conditions, including finding velocity functions from acceleration functions, finding position functions from velocity functions and solving applications related to motion along a line."

NAME \_\_\_\_\_

DATE \_\_\_\_\_

## BUILD THE FUNCTION

When you integrate a rate, include + C because many functions have the same derivative. Use the given value to solve for C. In motion, integrate acceleration to get velocity, then integrate velocity to get position.

## WORKED EXAMPLE

Find  $v(t)$  if  $a(t)=14t+11$  and  $v(0)=9$ .

1.  $v(t)=\int (14t+11) dt=7t^2+11t+C$ .

2. Use  $v(0)=9$ :  $9=C$ .

3. Substitute C:  $v(t)=7t^2+11t+9$ .

**Answer:  $v(t)=7t^2+11t+9$**

## PRACTICE 6 problems

**1** Find  $v(t)$  if  $a(t)=12t+8$  and  $v(5)=10$ .

ANSWER \_\_\_\_\_

**2** Find  $s(t)$  if  $v(t)=15t^2+4t$  and  $s(6)=12$ .

ANSWER \_\_\_\_\_

**3** Find  $v(t)$  if  $a(t)=16-10t$  and  $v(8)=13$ .

ANSWER \_\_\_\_\_

**4** Find  $s(t)$  if  $v(t)=20t-12$  and  $s(4)=8$ .

ANSWER \_\_\_\_\_

**5** Find  $f(x)$  if  $f'(x)=24x^3+10x$  and  $f(5)=15$ .

ANSWER \_\_\_\_\_

**6** Find  $s(t)$  if  $v(t)=24t^2-16t+12$  and  $s(2)=18$ .

ANSWER \_\_\_\_\_

## APPLY IT Show your work

- 1** A skateboard moves along a straight track. Its acceleration is  $a(t)=20t-8$  ft/s<sup>2</sup>, where  $t$  is measured in seconds. At  $t=2$ , its velocity is 16 ft/s and its position is 30 ft from a marker. Find its position at  $t=4$ .

WORK SPACE

ANSWER \_\_\_\_\_

- 2** A robotics team tests a cart moving along a straight rail. Its velocity is  $v(t)=12t^2+16t-20$  cm/s. At  $t=3$ , the cart is 24 cm from the rail's reference point. Find the cart's position at  $t=5$ .

WORK SPACE

ANSWER \_\_\_\_\_

## CHALLENGE One step up

### CHALLENGE

A cart moves along a line with acceleration  $a(t)=30t^2-24t+8$ . At  $t=2$ ,  $v(2)=12$  and  $s(2)=18$ . Find the position function, then find  $s(4)$ .

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## PART 1 • PRACTICE

| # | PROBLEM                                            | ANSWER                  |
|---|----------------------------------------------------|-------------------------|
| 1 | Find $v(t)$ if $a(t)=12t+8$ and $v(5)=10$ .        | $v(t)=6t^2+8t-180$      |
| 2 | Find $s(t)$ if $v(t)=15t^2+4t$ and $s(6)=12$ .     | $s(t)=5t^3+2t^2-1140$   |
| 3 | Find $v(t)$ if $a(t)=16-10t$ and $v(8)=13$ .       | $v(t)=16t-5t^2+205$     |
| 4 | Find $s(t)$ if $v(t)=20t-12$ and $s(4)=8$ .        | $s(t)=10t^2-12t-104$    |
| 5 | Find $f(x)$ if $f'(x)=24x^3+10x$ and $f(5)=15$ .   | $f(x)=6x^4+5x^2-3860$   |
| 6 | Find $s(t)$ if $v(t)=24t^2-16t+12$ and $s(2)=18$ . | $s(t)=8t^3-8t^2+12t-38$ |

## PART 2 • APPLY IT

1.  **$s(4)=458/3$  ft** Integrate acceleration and use  $v(2)=16$  to get  $v(t)=10t^2-8t-8$ . Integrate again, use  $s(2)=30$ , and evaluate the position function at  $t=4$ .
2.  **$s(5)=504$  cm** Integrate the velocity and use  $s(3)=24$  to get  $s(t)=4t^3+8t^2-20t-96$ . Substitute  $t=5$ .

## CHALLENGE

**$s(t)=5/2t^4-4t^3+4t^2-36t+66$ , and  $s(4)=370$**

Accept equivalent antiderivative forms, including reordered terms. Require students to use both initial conditions in the challenge to determine both constants.