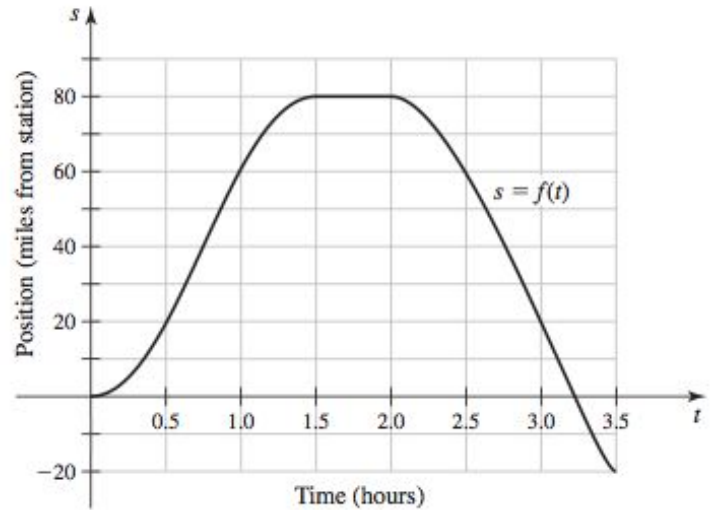## DEFINITION Instantaneous Velocity

The **(instantaneous) velocity** is the derivative of the position function $s = f(t)$ with respect to time. At time t the velocity is

$$v(t) = \frac{ds}{dt} =$$

1. Assume a police station is located along a straight east-west freeway. At noon (t=0), a patrol car leaves the station heading east. The position

   function of the car $s = f(t)$ gives the location of the car in miles east ($s > 0$)

   or west   ($s < 0$) of the station t hours after noon.

   a. Describe the location of the patrol car during the first 3.5 hours of the trip.

   b. Calculate the average velocity of the car between noon and 2:00 pm.

      $(0 \le t \le 2)$.

c. Calculate the displacement and average velocity of the car between 2:00 pm and 3:30 pm $(2 \leq t \leq 3.5)$

d. At what time(s) is the instantaneous velocity greatest *as the car travels east?*

e. At what time(s) is the patrol car at rest?

DEFINITION Speed

Speed is the absolute value of velocity.

$$\text{Speed} =$$

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2. A student walks around in front of a motion detector that records her velocity at 1-second intervals for 36 seconds. She stores the data in her graphing calculator and uses it to generate the **time-velocity graph** shown below. Describe her motion as a function of time by reading the velocity graph. When is her speed a maximum?
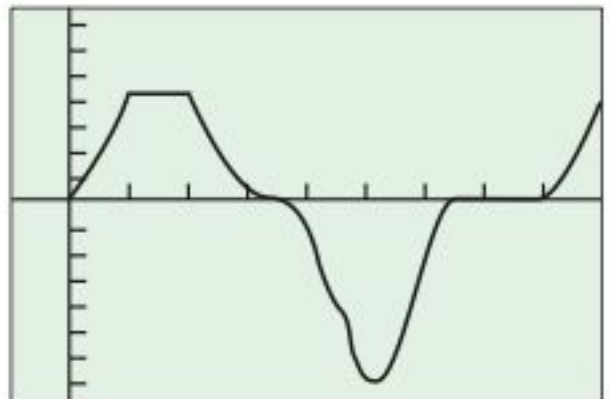
DEFINITION Acceleration

Acceleration is the derivative of velocity with respect to time. If a body's velocity at time t is $v(t) = ds/dt$, then the body's acceleration at time t is

$$a(t) =$$

2017 AP Test #5 → No Calculator

Two particles move along the x-axis. For $0 \le t \le 8$, the position of particle P at time t is given by

$x_P(t) = \ln\left(t^2 - 2t + 10\right)$, while the velocity of particle Q at time t is given by $v_Q(t) = t^2 - 8t + 15$.

Particle Q is at position $x = 5$ at time $t = 0$.

(a) For $0 \le t \le 8$, when is particle P moving to the left?

(b) For $0 \le t \le 8$, find all times t during which the two particles travel in the same direction.

(c) Find the acceleration of particle Q at time $t = 2$. Is the speed of particle Q increasing, decreasing, or neither at time $t = 2$? Explain your reasoning.

(d) Find the position of particle Q the first time it changes direction.

2016 AP Test #2 → Calculator Active

For $t \geq 0$, a particle moves along the x-axis. The velocity of the particle at time t is given by

$v(t) = 1 + 2\sin\left(\dfrac{t^2}{2}\right)$. The particle is at position $x = 2$ at time $t = 4$.

(a) At time $t = 4$, is the particle speeding up or slowing down?

(b) Find all times t in the interval $0 < t < 3$ when the particle changes direction. Justify your answer.

(c) Find the position of the particle at time $t = 0$.