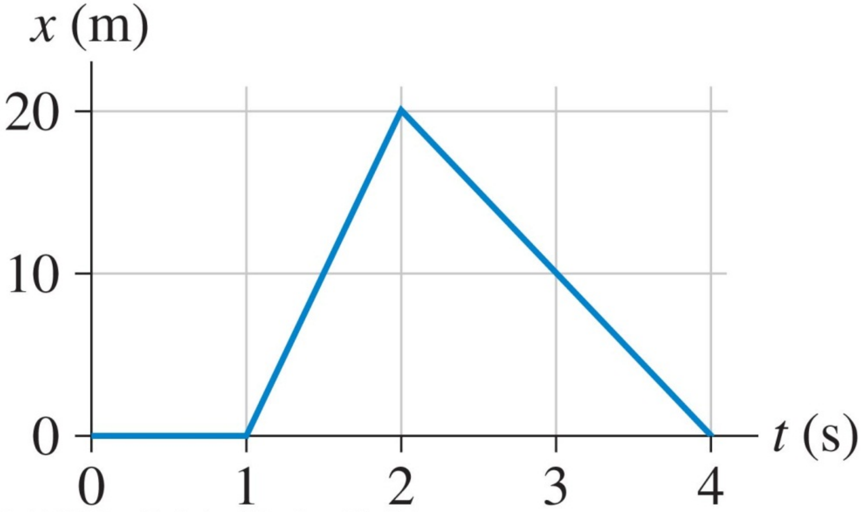
Whiteboard Problem 2.1 Solution

Here is a position graph of an object:



From t = 1s to t = 2s, the object's velocity is

v_x = (20-0) / (2-1) = 20 m/s

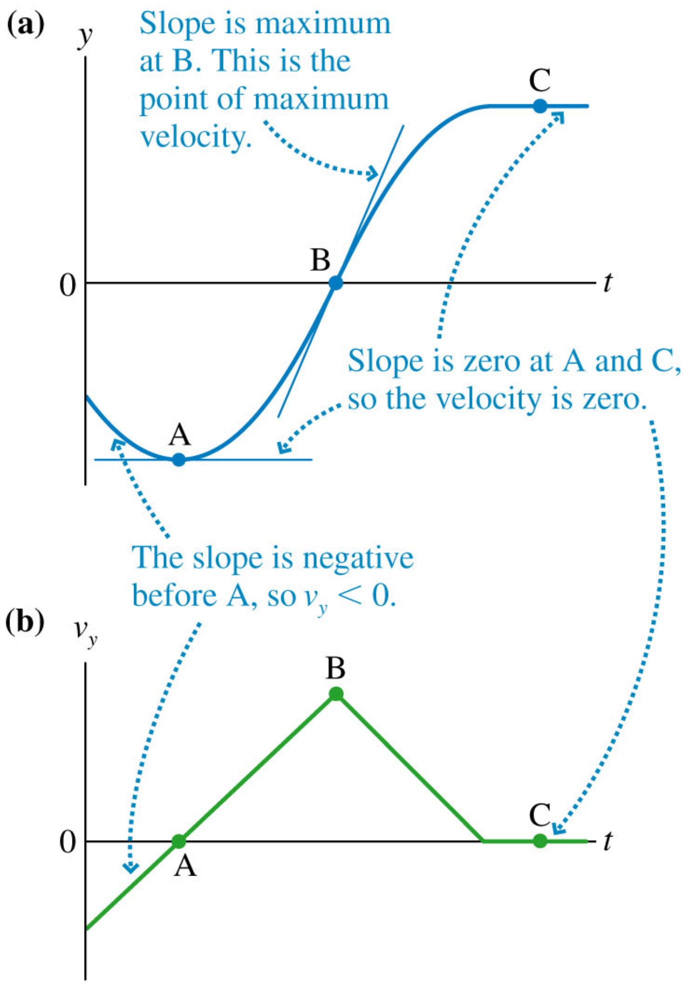
From t = 2s to t = 4s, the object's velocity is

v_x = (0-20) / (4-2) = -10 m/s

Whiteboard Problem 2.2 Solution: Finding Velocity from Position Graphically

Example 2.3 **Finding velocity from position graphically**

ASSESS Once again, the shape of the velocity graph bears no resemblance to the shape of the position graph. You must transfer *slope* information from the position graph to *value* information on the velocity graph.

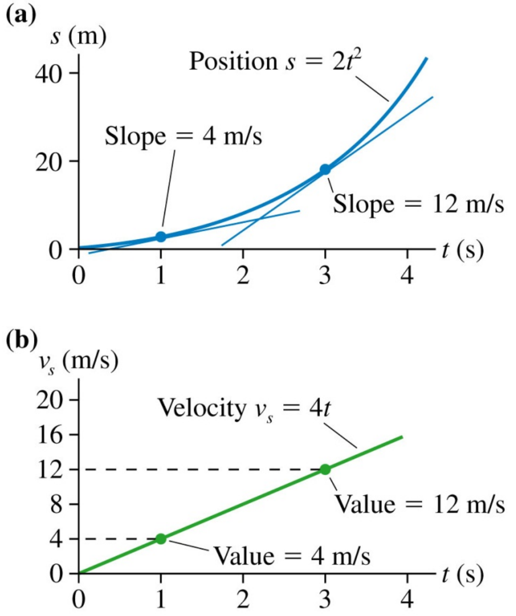


WHITEBOARD PROBLEM 2.3 SOLUTION

Suppose the position of a particle as a function of time is $s = 2t^2$ m where t is in s. Plot the particle's velocity as a function of time from $t = 0$ to 4 s.

Velocity is the derivative of *s* with respect to *t*:

$$v_s = \frac{ds}{dt} = 2 \cdot 2t^{2-1} = 4t$$



The *value* of the velocity graph at any instant of time is the *slope* of the position graph at that same time.

Calculate the derivatives $\left(\frac{d}{dx}\right)$ of the following functions:

$A)\ f(x) = 4x^1$ $= 4$

$B)\ f(x) = 2x^7 + x^2$ $= 14x^6 + 2x$

$C)\ f(x) = 1,000,000$ $= 0$

$D)\ f(x) = 5x + 67$ $= 5$

WHITEBOARD PROBLEM 2.4 SOLUTION

A particle moving along the x-axis has its position described by the function:

$$x = (2t^2 - t + 1)\ \mathrm{m}$$

where t is in seconds.

At t = 2 s what are the particle's

(A) position? $x(2\ \mathrm{s}) = (2 * [2^2] - 2 + 1)\ \mathrm{m}\ = (8 - 2 + 1)\ \mathrm{m} = 7\ \mathrm{m}$

(B) velocity?

$$v = \frac{dx}{dt} = (2 * 2t - 1 + 0)\ \mathrm{m/s}$$

$$v(2\ \mathrm{s}) = (2 * 2 * 2 - 1)\ \mathrm{m/s} = 7\ \mathrm{m/s}$$

(C) acceleration?

$$a = \frac{dv}{dt} = (2 * 2 * 1 - 0)\ \mathrm{m/s^2} = 4\ \mathrm{m/s^2}$$

Note: this is indicative of constant acceleration!

WHITEBOARD PROBLEM 2.5 SOLUTION

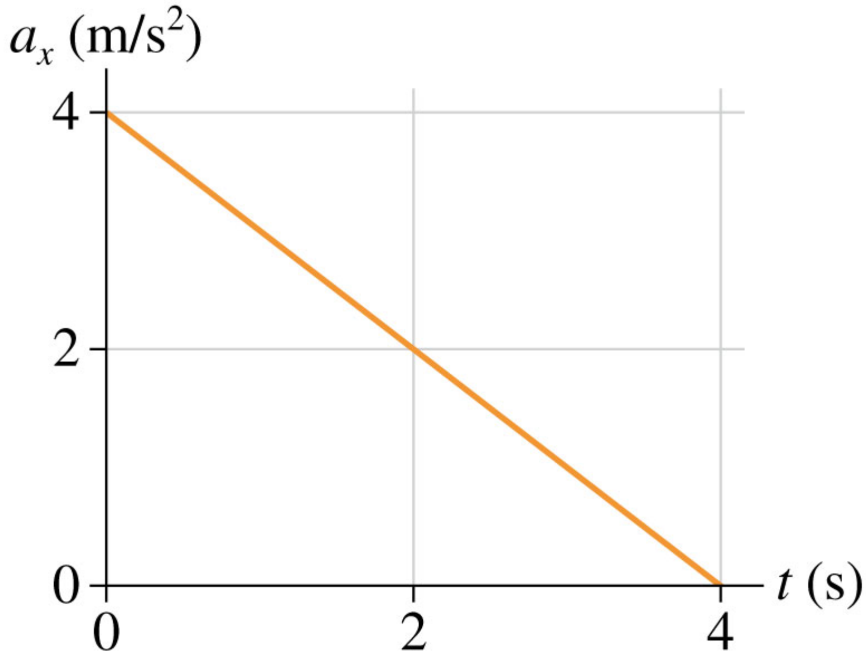
The below graph shows the acceleration vs time graph of a particle moving long the x-axis. Its initial velocity is v_{x0} = 8.0 m/s at t_0 = 0 s. What is the particle's velocity at 4.0 s?

$$\Delta v = \frac{1}{2} \cdot base \cdot height$$

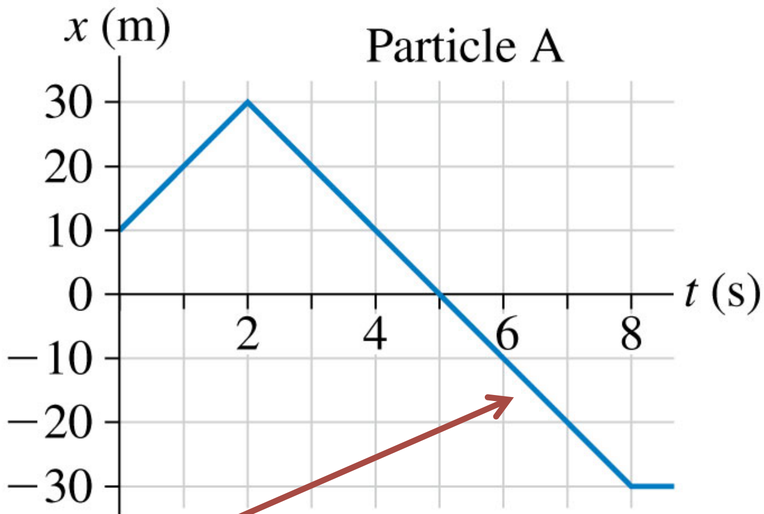
$$v_f = v_i + \frac{1}{2} \cdot 4\ \text{s} \cdot 4\ \text{m/s}^2$$

$$v_f = 8\ \text{m/s} + 8\ \text{m/s}$$

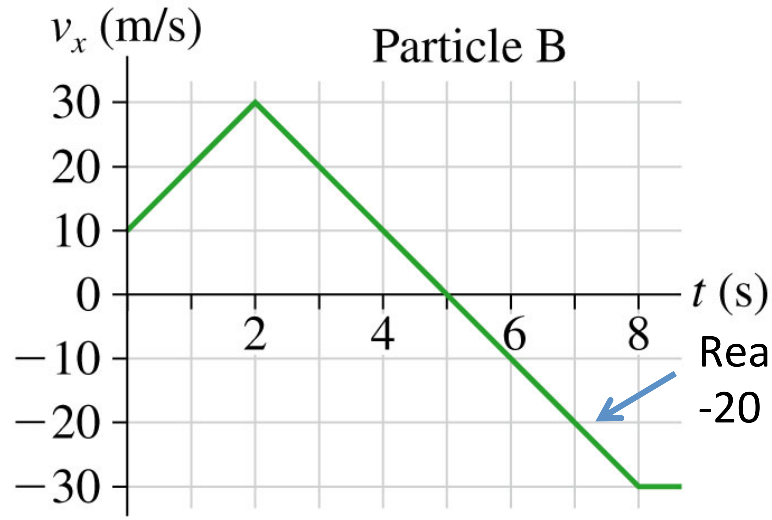
$$= 16\ \text{m/s}$$



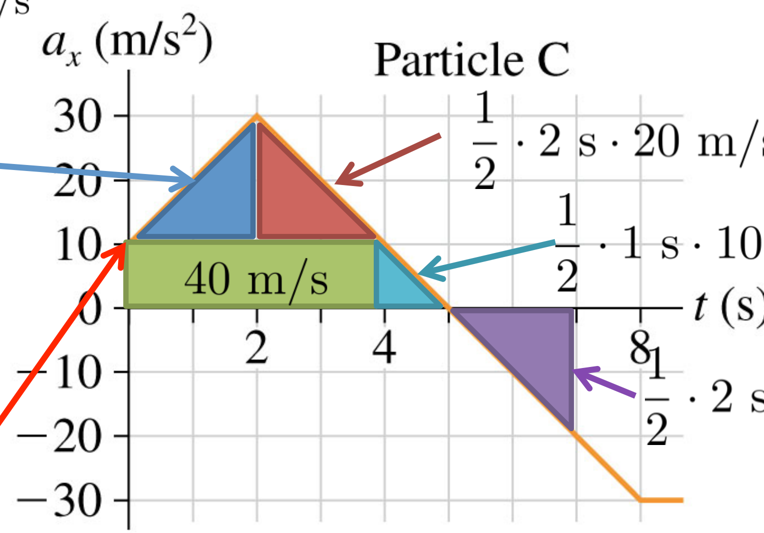
Whiteboard Problem 2.6 Solution



Slope: $\dfrac{-30\ \text{m} - 30\ \text{m}}{8\ \text{s} - 2\ \text{s}} = -10\ \text{m/s}$



Read it off:
-20 m/s



$\frac{1}{2} \cdot 2\ \text{s} \cdot 20\ \text{m/s}^2 = 20\ \text{m/s}$

$\frac{1}{2} \cdot 2\ \text{s} \cdot 20\ \text{m/s}^2 = 20\ \text{m/s}$

$\frac{1}{2} \cdot 1\ \text{s} \cdot 10\ \text{m/s}^2 = 5\ \text{m/s}$

$\frac{1}{2} \cdot 2\ \text{s} \cdot (-20\ \text{m/s}^2) = -20\ \text{m/s}$

From v_0

$$v_{total} = 10\ \text{m/s} + 40\ \text{m/s} + 20\ \text{m/s} + 20\ \text{m/s} + 5\ \text{m/s} - 20\ \text{m/s} = 75\ \text{m/s}$$