

Motion with Constant Velocity: Problem

PROBLEM

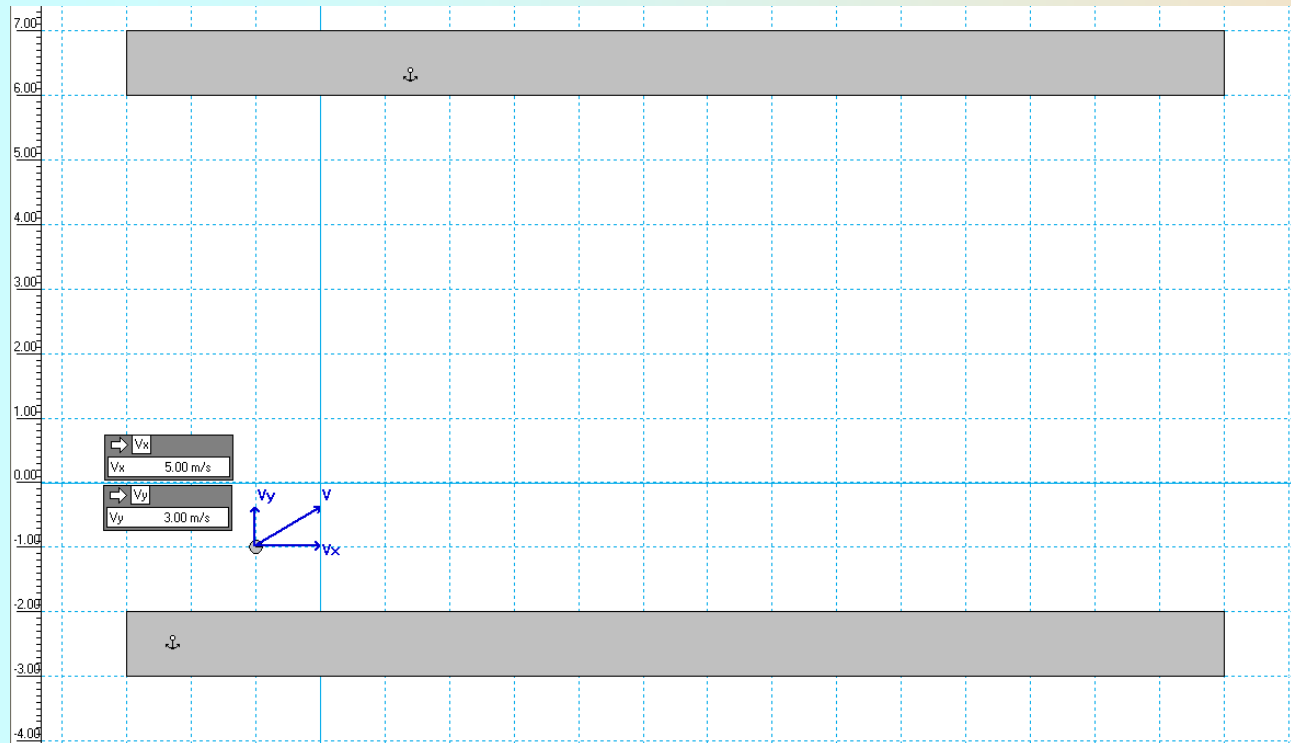
A body moves according to the picture,

initial position vector: $\vec{r}_0 = -\vec{i} - \vec{j}$ (m)

velocity: $\vec{v}_0 = 5\vec{i} + 3\vec{j}$ (m/s)

Determine:

- the equation of the position vector
- the position at $t=2.25$ s
- the point at which the body will hit the wall
- the displacement from the initial position to the moment in which the body hits the wall
- the magnitude and direction of the velocity



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SOLUTION

a) the equation of the position vector

$$\vec{r} = (-1 + 5*t) \vec{i} + (-1 + 3*t) \vec{j} \text{ (m)}$$

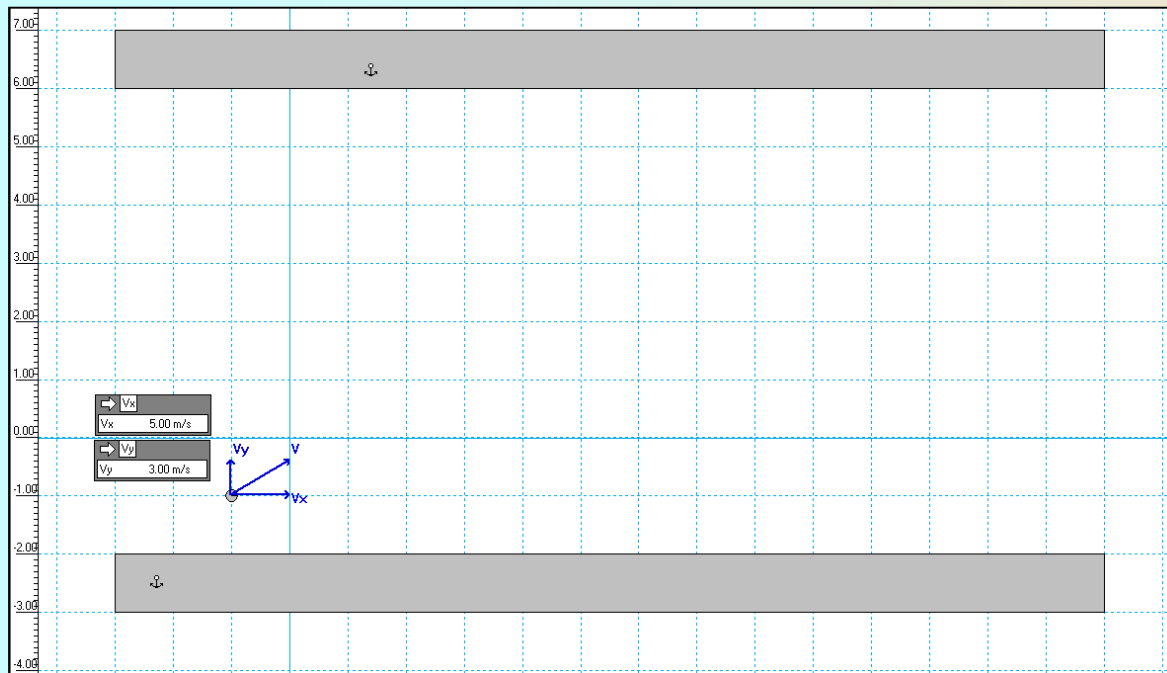
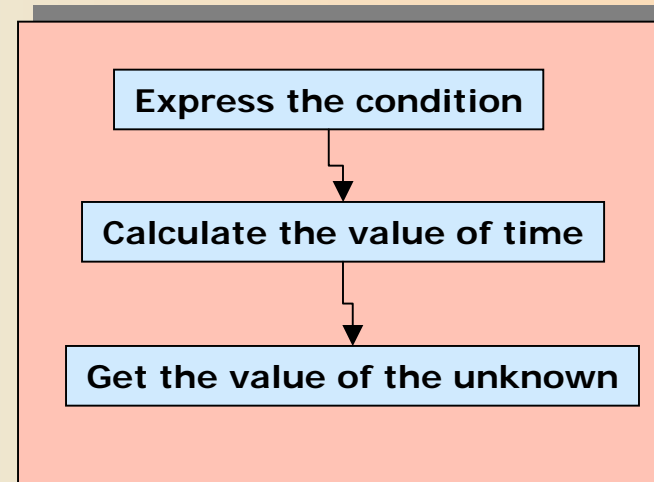
b) the position at $t=2.25$ s

$$\vec{r}_{t=2.25} = (-1 + 5*2.25) \vec{i} + (-1 + 3*2.25) \vec{j} \text{ (m)}$$

$$\vec{r}_{t=2.25} = 10.25 \vec{i} + 5.75 \vec{j} \text{ (m)}$$

c) the point at which the body will hit the wall

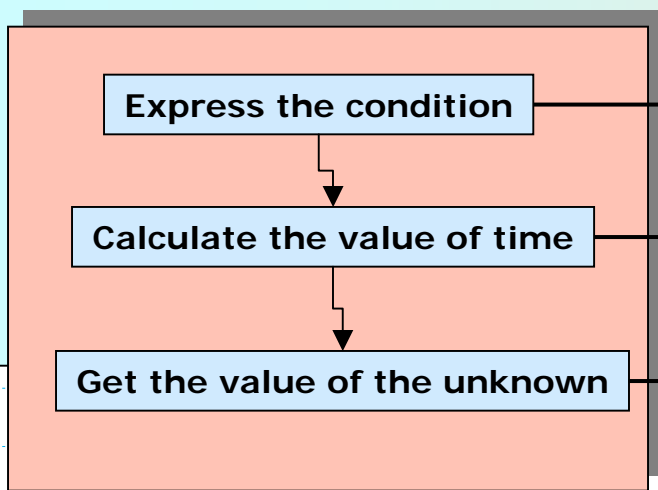
In this type of calculations (when a condition is set) the method is:



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SOLUTION

c) the point at which the body will hit the wall



Condition:
to hit the wall

$$y = 6 \text{ m}$$

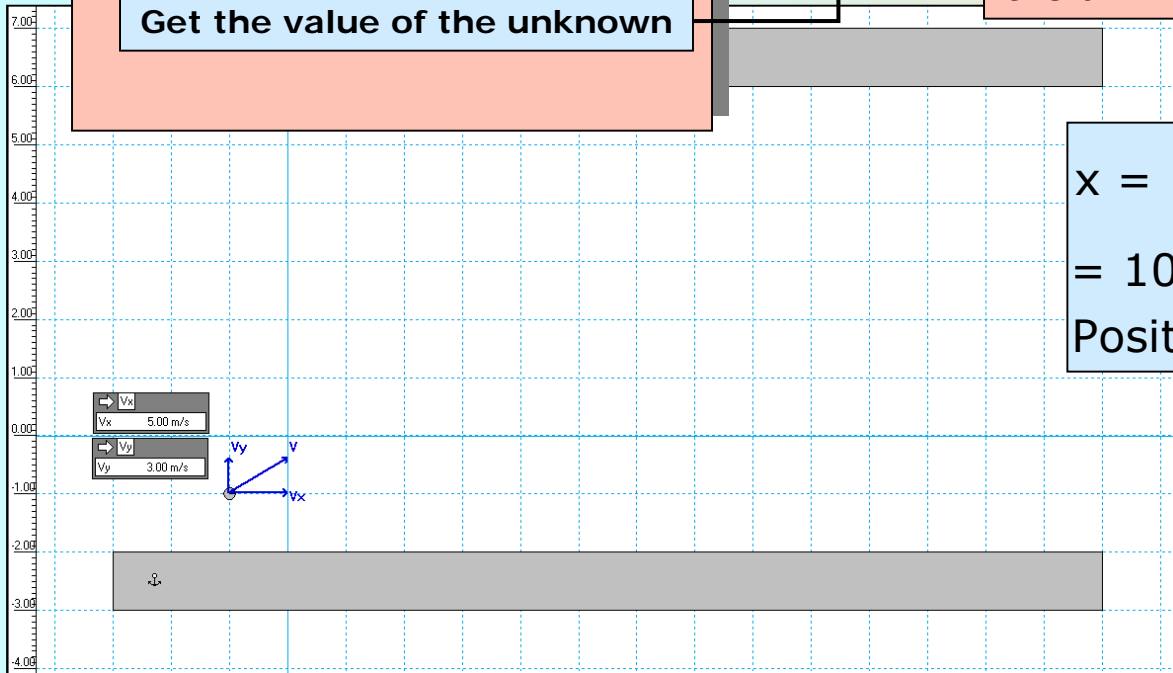
Calculate the value
of that moment (time)

$$y = 6 = -1 + 3*t \rightarrow t = \frac{7}{3} \approx 3.33 \text{ s}$$

Get the value of
the unknown (position)

$$x = -1 + 5*t \text{ (m)} = -1 + 5 * \frac{7}{3} = 10.67 \text{ m}$$

Position: $x = 10.67 \text{ m}; y = 6 \text{ m}$



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SOLUTION

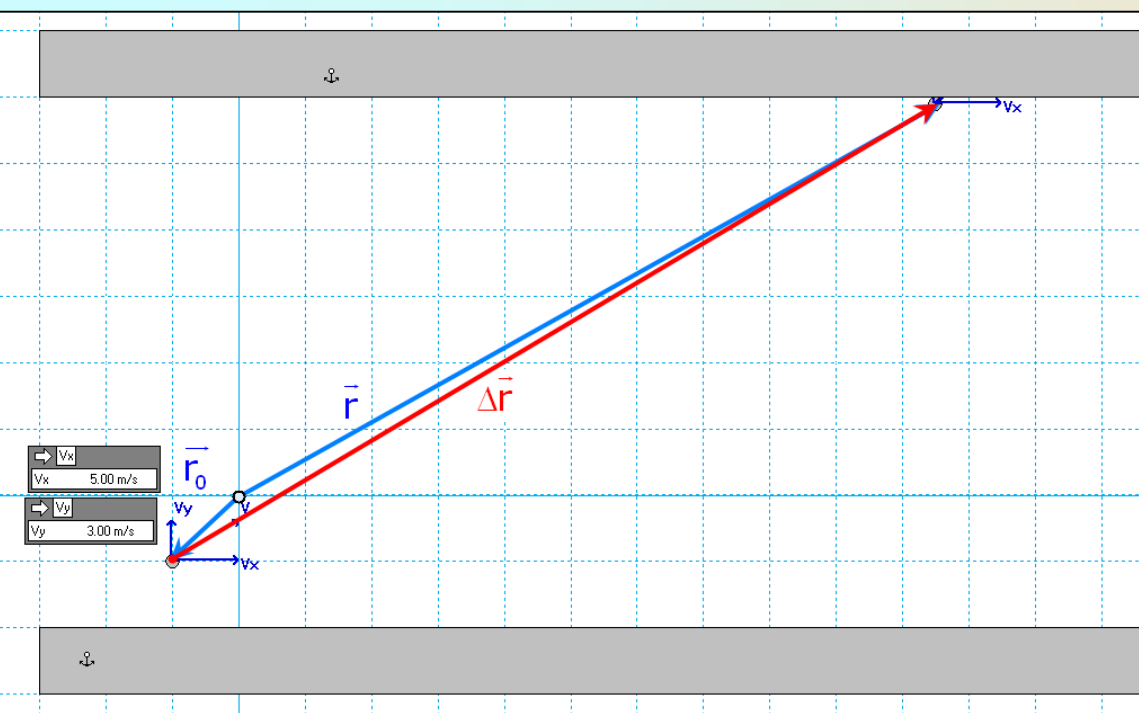
d) the displacement from the initial position to the moment in which the body hits the wall

There are at least two ways to calculate the displacement. The first method is:

$$\begin{aligned}\Delta\vec{r} &= \vec{r} - \vec{r}_0 = (10.67 \vec{i} + 6 \vec{j}) - (-\vec{i} - \vec{j}) = \\ &= 11.67 \vec{i} + 7 \vec{j}\end{aligned}$$

Another way to calculate the displacement is to use the definition of velocity (average velocity):

$$\begin{aligned}\vec{v} &= \frac{\Delta\vec{r}}{t} \rightarrow \Delta\vec{r} = \vec{v} * t = (5 \vec{i} + 3 \vec{j}) * \frac{7}{3} = \\ &= 11.67 \vec{i} + 7 \vec{j} \text{ (m)}\end{aligned}$$



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SOLUTION

e) the magnitude and direction of the velocity

$$|v| = \sqrt{\left(3 \frac{\text{m}}{\text{s}}\right)^2 + \left(5 \frac{\text{m}}{\text{s}}\right)^2} = 5.83 \frac{\text{m}}{\text{s}}$$

$$\alpha = \tan^{-1} \frac{3}{5} = 31^\circ$$

