Rafa Muñoa
Lizardi Institutua
Zarautz

Equations of motion

Initial values

Position: x_0, y_0
Velocity: v_{0x}, v_{0y}
Acceleration: a_x, a_y

Position vector: equation

$$\vec{r} = \underbrace{(x_0 + v_{0x} * t + \frac{1}{2} a_x * t^2)\,\vec{i}}_{\text{“X” component}} + \underbrace{(y_0 + v_{0y} * t + \frac{1}{2} a_y * t^2)\,\vec{j}}_{\text{“Y” component}}$$

t =

position at any moment

displacement change in position

$$\Delta\vec{r} = \vec{r} - \vec{r}_0$$

derivative

Derivative: rules

$t^n \xrightarrow{\text{derivative}} n*t^{n-1}$

$k*t^n \xrightarrow{\text{derivative}} k*n*t^{n-1}$

$k \xrightarrow{\text{derivative}} 0$

Velocity – rate of change in position

$$\vec{v} = \underbrace{(v_{0x} + a_x * t)\,\vec{i}}_{\text{“X” component}} + \underbrace{(v_{0y} + a_y * t)\,\vec{j}}_{\text{“Y” component}}$$

t =

velocity at any moment

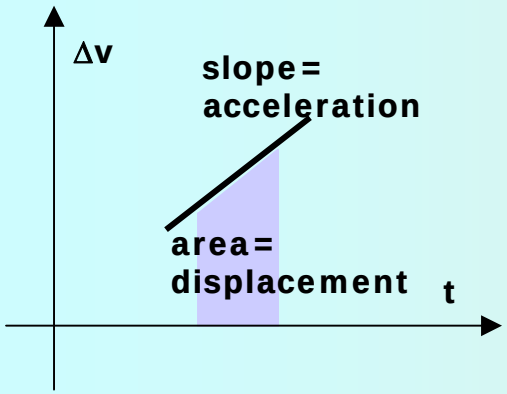
change in velocity

$$\Delta\vec{v} = \vec{v} - \vec{v}_0$$

derivative

Acceleration – rate of change in velocity

$$\vec{a} = a_x\,\vec{i} + a_y\,\vec{j}$$

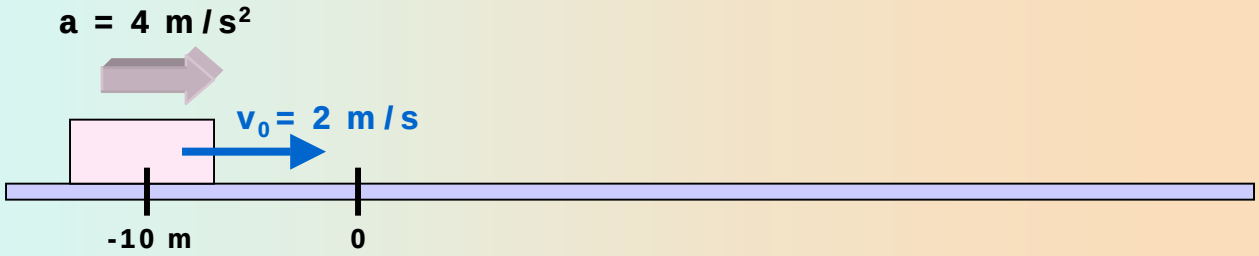


Rafa Muñoa
Lizardi Institutua
Zarautz

Equations of motion

Initial values

Position: x_0, y_0
Velocity: v_{0x}, v_{0y}
Acceleration: a_x, a_y



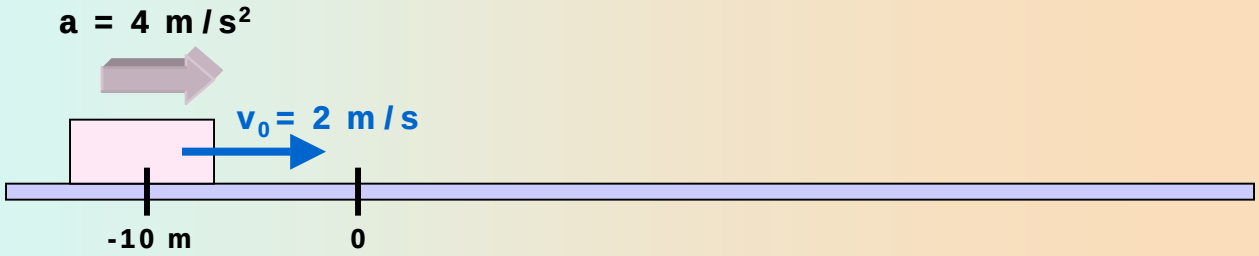
Determine:
- the equation of the position vector
- the displacement between t=2 s and t=4 s
- the average velocity between t=2 s and t=4 s
- the equation of the velocity
- the velocities at t=2 s and t=4 s

Rafa Muñoa
Lizardi Institutua
Zarautz

Equations of motion

Initial values

Position: x_0, y_0
Velocity: v_{0x}, v_{0y}
Acceleration: a_x, a_y



Determine:

- the equation of the position vector

$$\vec{r} = \left(-10\ m + 2\ \frac{m}{s} * t + 2\ \frac{m}{s^2} * t^2\right) \vec{i}$$

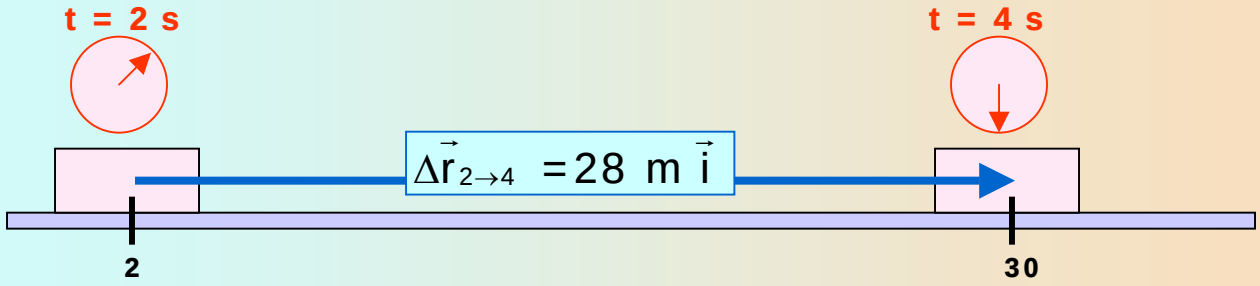
- the displacement between t=2 s and t=4 s

$$\vec{r_2} = (-10\ m + 4\ m + 8\ m)\ \vec{i} = 2\ m\ \vec{i}$$

$$\vec{r_4} = (-10\ m + 8\ m + 32\ m)\ \vec{i} = 30\ m\ \vec{i}$$

$$\Delta\vec{r}_{2\to4} = \vec{r_4} - \vec{r_2} = 30\ m\ \vec{i} - 2\ m\ \vec{i} = 28\ m\ \vec{i}$$

- the average velocity between t=2 s and t=4 s
- the equation of the velocity
- the velocities at t=2 s and t=4 s

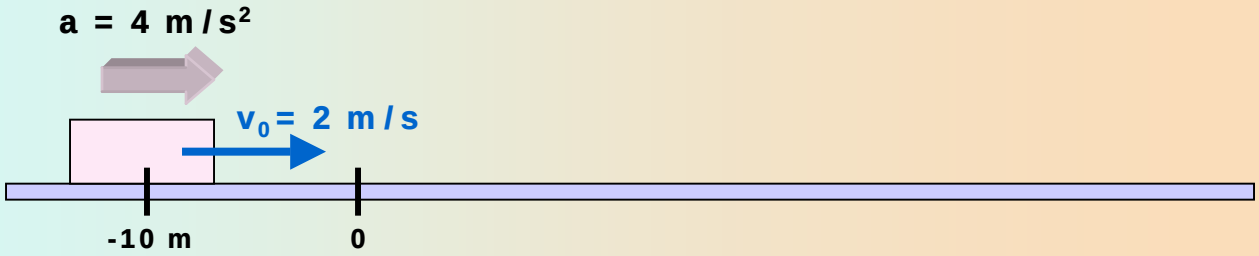


Rafa Muñoa
Lizardi Institutua
Zarautz

Equations of motion

Initial values

Position: x_0, y_0
Velocity: v_{0x}, v_{0y}
Acceleration: a_x, a_y



Determine:

the average velocity between t=2 s and t=4 s

•the equation of the velocity

•the velocities at t=2 s and t=4 s

$$\Delta\vec{r}_{2\to4} = \vec{r}_4 - \vec{r}_2 = 30\ m\ \vec{i} - 2\ m\ \vec{i} = 28\ m\ \vec{i}$$

$$\vec{v} = \frac{\Delta\vec{r}_{2\to4}}{t} = \frac{28\ m\ \vec{i}}{4\ s - 2\ s} = 14\ \frac{m}{s}\ \vec{i}$$

$$\vec{r} = \left(-10\ m + 2\ \frac{m}{s} * t + 2\ \frac{m}{s^2} * t^2\right)\vec{i}$$

↓ derivative

$$\vec{v} = \left(2\ \frac{m}{s} + 4\ \frac{m}{s^2} * t\right)\vec{i}$$

$$\vec{v_2} = \left(2\ \frac{m}{s} + 8\ \frac{m}{s}\right)\vec{i} = 10\ \frac{m}{s}\ \vec{i}$$

$$\vec{v_4} = \left(2\ \frac{m}{s} + 16\ \frac{m}{s}\right)\vec{i} = 18\ \frac{m}{s}\ \vec{i}$$