Lecture January 22

Structured problem solving approach:

Identify

which object is moving?

Define origin, axes of coordinate system

How is position $\vec{r}(t)$ (in 1-dim $x(t)$) measured?

Define initial conditions

Initial time t_0

$x(t_0) = x_0$

$\vec{r}(t_0) = (x_0, y_0, z_0)$ $[\vec{r}_0]$

velocity

$v(t_0) = v_0$

$\vec{v}(t_0) = (v_{x0}, v_{y0}, v_{z0})$

$[\vec{v}_0]$

↓

MODEL

- Find the forces acting on object
- Introduce models of the forces
- apply Newton's 2nd law

$$m\vec{a} = \vec{F} \Rightarrow$$

$$\vec{a} = \frac{d^2\vec{r}}{dt^2} = \vec{F}/m$$

↓

solve

solve the equations

$$\vec{a} = \frac{d^2\vec{r}}{dt^2} = \ddot{\vec{r}}$$

$$\vec{a} = \frac{d\vec{v}}{dt} = \dot{\vec{v}}$$

instantaneous acceleration

$$\vec{v} = \frac{d\vec{r}}{dt} = \dot{\vec{r}}$$

at

↗ instantaneous velocity

$$\vec{a} = \frac{d\vec{v}}{dt} = \frac{d^2\vec{r}}{dt^2}$$ ← 2nd order diff eq.

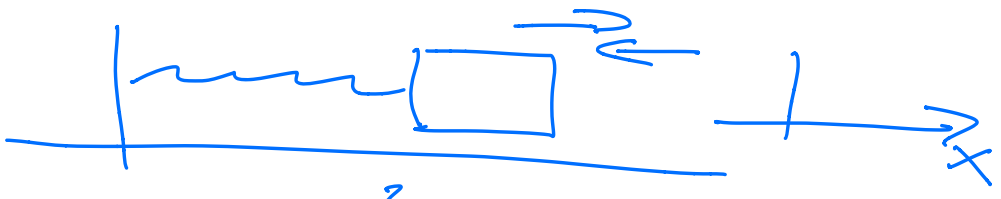
Define initial conditions $\vec{v}_0$ and $\vec{r}_0$

written out as two coupled First order Diff eq.

$$\frac{d\vec{v}}{dt} = \vec{a}$$

$$\frac{d\vec{r}}{dt} = \vec{v}$$

Example: sliding Block



$$m\frac{d^2x}{dt^2} = m\ddot{x} = -kx(t)$$

$$\ddot{x}(t) = a$$

$$a(t) = -\frac{k}{m}x(t)$$

x_0 and v_0

$$\frac{dv(t)}{dt} = a(t) = -\frac{k}{m}x(t)$$

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

$\Downarrow$

analyze

check validity of
$x(t)$ and $v(t)$

- what do they mean?
- Evaluate answer
  ⋮