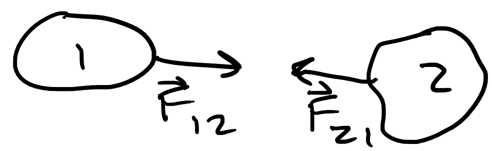
A First Law: Every body perseveres in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impress'd thereon.

B Second Law: The $\underbrace{\text{alteration of motion}}_{}$ $\vec{a}$ is ever proportional to the motive force impress'd; and is made in the direction of the right (straight) line in which that force is impress'd. $\vec{F} = m\vec{a}$

C Third Law: To every Action there is always opposed an equal Reaction: or the mutual actions of two bodies upon each other are always equal, and directed to contrary parts. $\vec{F}_{12} = \vec{F}_{21}$



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

C $\vec{F}_{12} = \vec{F}_{21}$

A $\vec{a} = 0 \Rightarrow \vec{r} = \vec{r}_0 + t\vec{v}$

Newton's equs $\vec{F} = m\vec{a}$ point masses $\left\{ \begin{array}{l} m \\ \vec{r} \\ \vec{v} \\ \vec{a} \end{array} \right.$

total force acting on mass

approximation for slow, light, large things.

2 ways to use $\vec{F} = m\vec{a}$

① method of assumed forces

know (assume) forces $\Rightarrow$ calculate $\vec{a}$

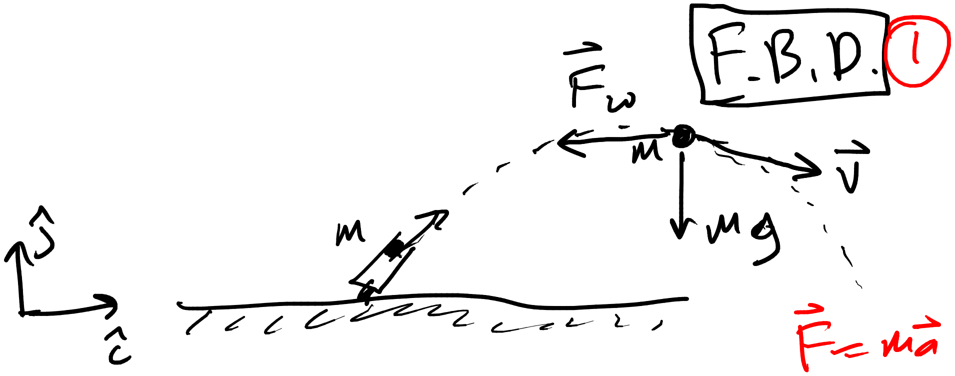
$\Rightarrow \vec{v}, \vec{r}$

② method of assumed motion

know (assume) motion $(\vec{r}(t), \vec{v}(t), \vec{a}(t))$

$\Rightarrow$ calculate $\vec{F}$

ex method of assumed forces



2 forces

air resistance : $\vec{F}_w = -C_w \hat{i}$

gravity: $\vec{F}_g = -mg\hat{j}$

↑

model.

$\vec{F} = m\vec{a}$ 3 $m\vec{a} = \vec{F} = \vec{F}_w + \vec{F}_g = -C_w\hat{i} - mg\hat{j}$

$$\ddot{\vec{r}} = \vec{a} = -\frac{C_w}{m}\hat{i} - g\hat{j}$$

algebra
calculus

4 $\vec{r}(t) = \vec{r}_o + \vec{v}_o t + \frac{1}{2}t^2\left(-\frac{C_w}{m}\hat{i} - g\hat{j}\right)$

$\vec{r} = x\hat{i} + y\hat{j}$

$$x(t) = x_o + v_{xo}t - \frac{1}{2}t^2\frac{C_w}{m}$$

$$y(t) = y_o + v_{yo}t - \frac{1}{2}t^2 g$$

ex method of assumed motion

constant $\underline{v_x = c}$ ground height $y = A\cos(kx)$

there is gravity

<u>Q</u> what is the force of the road on the car?

find acc: $\vec{r} = x\hat{i} + y\hat{j}$

find motion ① $= (x_0 + ct)\hat{i} + A\cos(k(x_0+ct))\hat{j}$

$\dot{x} = v_x = c$

$x = x_0 + ct$

$$\dot{\vec{r}} = \vec{v} = c\hat{i} - A\sin(k(x_0+ct))\,kc\,\hat{j}$$

$$\ddot{\vec{r}} = \dot{\vec{v}} = \vec{a} \overset{②}{=} -A\cos(k(x_0+ct))(kc)^2\hat{j}$$

find $\vec{a}$

$$-mg\hat{j} + \vec{F}_r = \vec{F}_g + \vec{F}_r = \vec{F} \overset{③}{=} m\vec{a} = -mA\cos(k(x_0+ct))(kc)^2\hat{j}$$

want

total force on car

④ algebra

$$\vec{F}_r = mg\hat{j} - mA\cos(k(x_0+ct))(kc)^2\hat{j}$$