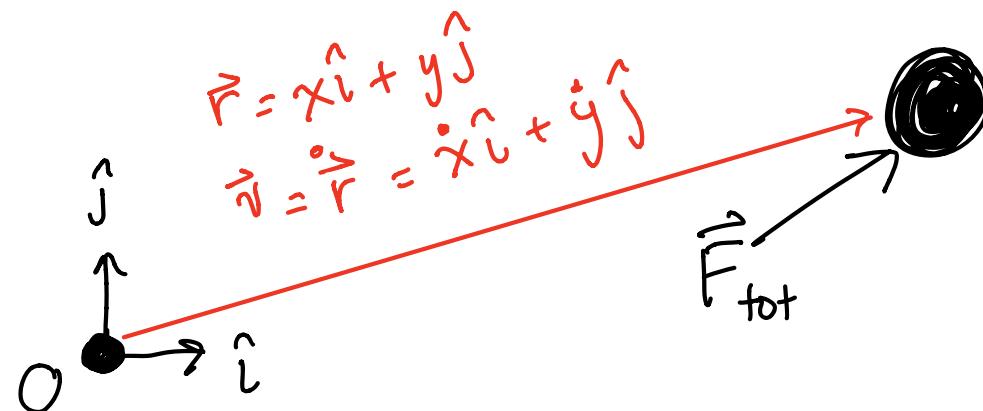


Today : ① Dynamics of particles in 2D (& 3D)
 ② More MATLAB tricks ['Events']

(& 3D)

2D dynamics of particles!



$$\text{LMB: } \sum_i \vec{F}_i = \ddot{\vec{L}}$$

$$\vec{F}_{\text{tot}} = m \vec{a}$$

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

$$\left\{ \begin{array}{l} \begin{bmatrix} \dot{x} \\ \dot{y} \end{bmatrix} = \begin{bmatrix} v_x \\ v_y \end{bmatrix} \\ \begin{bmatrix} \dot{v}_x \\ \dot{v}_y \end{bmatrix} = \begin{bmatrix} f_x \\ f_y \end{bmatrix} / m \end{array} \right. \quad \Leftrightarrow \quad \boxed{\begin{array}{l} \dot{\vec{r}} = \vec{v} \\ \dot{\vec{v}} = \frac{\vec{F}_{\text{tot}}}{m} \end{array}}$$

All forces of interest

$$\vec{F} = \vec{F}(t, \vec{r}, \vec{v})$$

ex) near earth gravity

$$\vec{F} = -mg\hat{j}$$

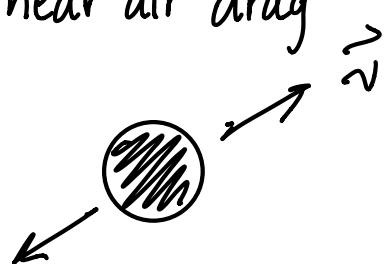
ex) inverse squared gravity

A diagram showing two objects. On the left is a large circle labeled M_1 . To its right is a smaller circle labeled m_2 . A dashed line connects them, with a vector arrow labeled \vec{r}_{211} pointing from M_1 towards m_2 . A horizontal dashed line extends from m_2 to the right, with a vector arrow labeled \vec{F}_{211} pointing along this line away from M_1 .

$$\vec{F} = -\frac{GM_1m_2}{|\vec{r}_{211}|^2} \cdot \frac{\vec{r}_{211}}{|\vec{r}_{211}|}$$

$$F = -\frac{GM_1m_2}{|\vec{r}_{211}|^3} \cdot \vec{r}_{211}$$

ex) linear air drag



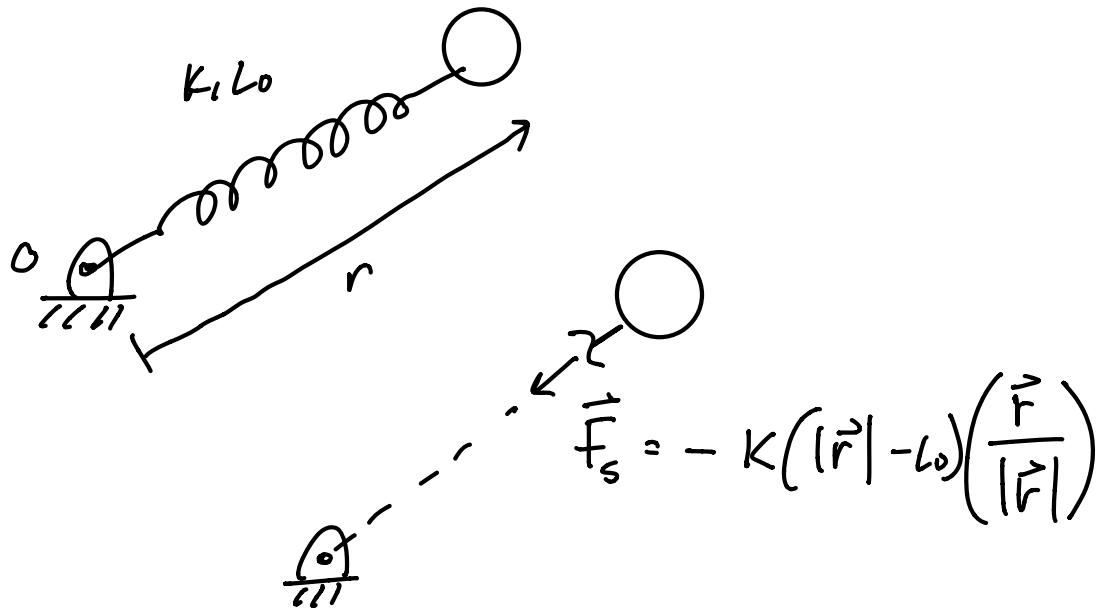
$$\vec{F}_D = C_D |\vec{v}| \left(\frac{-\vec{v}}{|\vec{v}|} \right) = -C_D \vec{v}$$

ex) quadratic drag

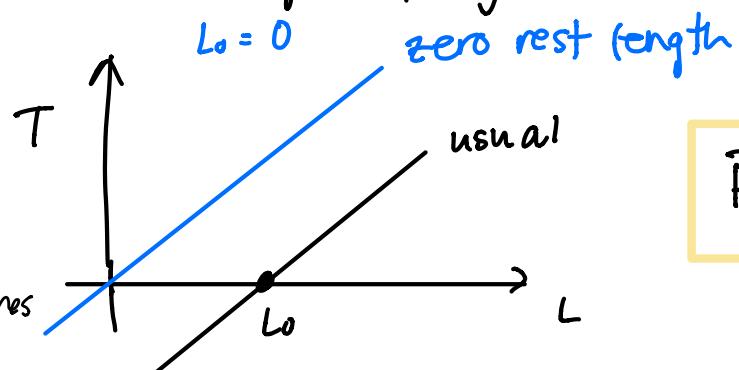
$$\vec{F}_{DQ} = -C_{DQ} |\vec{v}|^2 \left(\frac{\vec{v}}{|\vec{v}|} \right)$$

$$\boxed{\vec{F}_{DQ} = -C_{DQ} |\vec{v}| \cdot \vec{v}}$$

ex) linear spring



ex) zero rest length spring



$$\boxed{\vec{F}_s = -k\vec{r}}$$

demo: More fun MATLAB commands :