Kinematic Equations for uniform acceleration ... in 2-D

(Sec. 4.2) If $\vec{a} = a_x\hat{\imath} + a_y\hat{\jmath}$, you can write an x and y version of 2.13-2.17.

* Recall (2.13) $v_{xf} = v_{xi} + a_x t$, ..., (2.17) $v_{xf}^2 - v_{xi}^2 = 2a_x(x_f - x_i)$
* Each of them can also be written in terms of y ...

$$v_{yf} = v_{yi} + a_y t, \quad \ldots, \quad v_{yf}^2 - v_{yi}^2 = 2a_y(y_f - y_i)$$

* The x & y versions can be multiplied by $\hat{\imath}$ and $\hat{\jmath}$, respectively.

$$v_{xf}\hat{\imath} = v_{xi}\hat{\imath} + a_x t\hat{\imath} \quad \text{and} \quad v_{yf}\hat{\jmath} = v_{yi}\hat{\jmath} + a_y t\hat{\jmath}$$

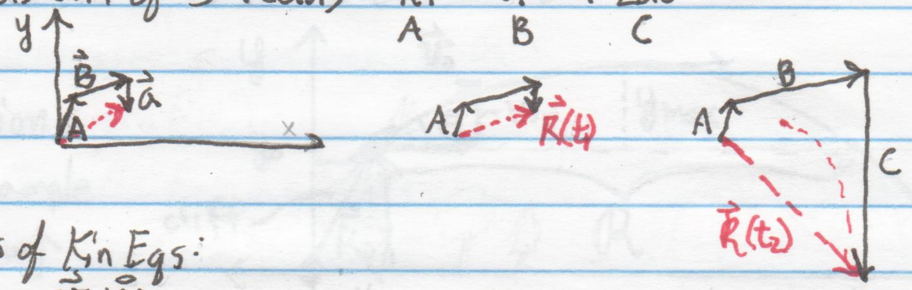
* Adding these gives vector versions of 2.13-2.17 gives

$$(2.13) \rightarrow \vec{v}_f = \vec{v}_i + \vec{a}t$$

$$v_{xf}\hat{\imath} + v_{yf}\hat{\jmath} = v_{xi}\hat{\imath} + v_{yi}\hat{\jmath} + (a_x\hat{\imath} + a_y\hat{\jmath})t$$

$$(2.16) \rightarrow \boxed{\vec{R}_f = \vec{R}_i + \vec{v}_i t + \tfrac{1}{2}\vec{a}t^2} = \vec{R}(t)$$

[SWF 4.5] Visualize $\vec{R}(t)$ as sum of 3 vectors $\underset{A}{\vec{R}_i} + \underset{B}{\vec{v}_i t} + \underset{C}{\tfrac{1}{2}\vec{a}t^2}$



* Other 2-D versions of Kin Eqs:

$$(2.14) \rightarrow \vec{v}_{avg} = \frac{\vec{v}_i + \vec{v}_f}{2}$$

$$(2.15) \rightarrow \vec{R}_f = \vec{R}_i + \tfrac{1}{2}(\vec{v}_i + \vec{v}_f)t$$

$$(2.17) \rightarrow \vec{v}_f \cdot \vec{v}_f - \vec{v}_i \cdot \vec{v}_i = 2\vec{a} \cdot (\vec{R}_f - \vec{R}_i)$$ [dot products come later]

Example: swimming fish [Back 2 pages]

(Sec. 4.3)

Projectile Motion

* A special case of 2D motion in which $\vec{a} = 0\hat{\imath} - 9.8\hat{\jmath}\ m/s^2$.
* Paths (trajectories) are parabolas.
* Ignore air resistance
* $\vec{R}(t) = R_x(t)\hat{\imath} + R_y(t)\hat{\jmath}$

where $R_x(t) = R_{ox} + v_{ox}t$

$R_y(t) = R_{oy} + v_{oy}t + \tfrac{1}{2}a_y t^2$